THE INTERPLAY OF CREDIT, SAVINGS, AND VULNERABILITY: A STUDY OF FINANCIAL INCLUSION IN KENYA

A Thesis

Presented to the Faculty of the Graduate School

of Cornell University

In Partial Fulfillment of the Requirements for the Degree of

Master of Science

By

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May 2017

ABSTRACT

The rise in weather shocks in Kenya has compromised farmers' ability to smooth consumption, rendering farmers more vulnerable. In light of this development, it is essential to analyze the relationship between that vulnerability and the usage of different financial services, and the reverse role of vulnerability on the take up of these services. I run a simultaneous three-stage-least square model to control for the endogeneity and identify the interplay between usage of credit, savings, and vulnerability. I find that no variable significantly influences the usage of any form of credit, which has a significant and positive impact on savings and vulnerability through loans from informal sources. I also find strong evidence of a substitution effect between taking loans from formal sources and taking loans from informal sources, since the two are asymmetrically correlated with vulnerability. External credit rationing is the most likely culprit. Additionally, I demonstrate that financial penetration does not guarantee the usage of services such as credit, and is therefore insufficient in tackling vulnerability.

BIOGRAPHICAL SKETCH

Anthony Nasr was born January 25, 1994 in Jounieh, Lebanon. He pursued a Bachelors degree in Economics at the American University of Beirut, and graduated in May 2015 with an unexpected minor in Creative Writing as well. He is currently a Master of Science candidate in Applied Economics and Management at Cornell University. He has accepted a position as an Analyst in economic consulting at Analysis Group.

ACKNOWLEDGEMENTS

I wish to sincerely acknowledge all the people who guided me through my master's studies and all the people who helped make this experience rewarding. First and foremost, I am extremely grateful for the guidance and support of Dr. Calum Turvey, my advisor, without whom I could not have tackled such a research project. I would like to thank you for all the advice you have given me about my research and about life in general, and for caring immensely about my own success. I wish to also thank Dr. Joshua Woodard for serving on my committee and for providing crucial help in finishing my thesis.

This thesis was financially supported through SATISFy, a World Bank Challenge grant, with Dr. Apurba Shee, IFPRI Tanzania, as Principal Investigator.

I also like to thank my dearest friends and family who embarked on this journey with me. Thank you Rawad Nasr for making this entire experience possible. Thank you Joaquin Perez and Rachel Saputo for all the wine and entertainment when things got rough. And a final thank you to my best friend, Ben Figoten, for the endless fun and support, and for helping me figure out how to number these pages.

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CHAPTER I

INTRODUCTION

1.1 Background

Despite attempts at strengthening the breadth and depth of financial inclusion in developing nations, access to financial services has not guaranteed increased usage of those services (Beck et al, 2005). Development of financial intermediaries has led to stronger economic development on a macro scale, but the results are less clear on an individual level. Beck has demonstrated that reducing financial hurdles does increase the usage of financial services such as loans. Yet the level of adoption of loans from formal financial institutions remains significantly low in developing economies (Demirguc-Kunt, Klapper, 2012).

Ironically, demand for credit – and insurance – in those economies is high (Murdoch, 1995). Policies have targeted the extent of financial penetration, and have sought to encourage the usage of services and the adoption of credit. The reason for that is, in markets with proper insurance and credit, shocks do not affect households' consumption, since borrowing and savings can smooth away the risk. Farmers in those markets, a key sample group in this research, do not alter their production methods (Murdoch, 1995).

On the other hand, in markets where farmers face barriers against these services, risk aversion ensues. Farmers resort to conservative farming techniques. Binswanger and Rosenzweig (1993) demonstrated that vulnerable households shifted their production into less profitable territories. For example, households at the lowest level of income would lose around 35 percent of their profit as a result of income smoothing.

This paper attempts to determine the interrelated role that *usage* of different financial services – specifically savings and credit - plays on an individual's vulnerability to shocks (and therefore

that individual's ability to smooth away shocks). The paper covers the simultaneous correlation between these variables across different stages and the direction of the linkage between all three. Additionally, the paper addresses the different factors encouraging and hindering demand for these services and influencing people's vulnerability to shocks.

This research focuses on Kenya. Kenya has witnessed an increase in the number of weather shocks over the years, which severely impacts farmers' vulnerability (IRLI 2007, Funk et. Al 2010). In addition, a large portion of the population lives below the poverty line, with 80 percent of farmers categorized as subsistence farmers (World Bank 2012). Not surprisingly, these farmers have shown little adoption of loans from formal institutions. Policymakers have attributed this to the lack of access to formal sources of credit, yet only 9.67 percent of non-farmers in my sample, who supposedly have better access to credit, have taken out loans from formal lending sources. Therefore, I seek to determine the extent of which financial inclusion affects the usage of services such as savings and lending, and then proceed to analyze these services' respective roles on people's vulnerability, and vice versa.

This analysis will also serve as a preliminary to the "SATISFy" project. This project seeks to introduce Kenyan farmers to Risk-Contingent Credit (RCC), a credit instrument with built-in insurance against weather shocks, with the intention of encouraging farmers to adopt loans or credit while minimizing their vulnerability. Since this paper analyzes the linkage between credit and vulnerability, it will help determine the potential demand for this product and the factors that could be driving it.

This paper finds that Kenyans rely heavily on loans from informal sources, while the market for formal credit is extremely small and insignificant in its effect on the usage of other services and individuals' perception of their own risk. Very little drives the demand for credit, for both

farmers and non-farmers. Neither financial inclusion, nor systematic characteristics such as cost of services or the documents required determine demand. Most literature would point to collateral requirements as a significant factor, and it is therefore important to note that the survey used did not measure that variable.

Having a bank account and where respondents fell in terms of income quintile significantly influenced the level of savings, yet only with non-farmers. Credit and savings positively influenced each other, yet only significantly with credit's influence on savings. Savings reduced one's vulnerability across the board, yet credit displayed a positive effect on vulnerability. This result is isolated to informal credit – which is basically a cause of anxiety. Financial inclusion is clearly proven to be a weak determinant of usage of services and therefore vulnerability.

Meanwhile, formal credit is a weak and untapped market, yet it is unclear if it is due to reluctant demand. In fact, I find strong evidence that points to a deficient supply of credit. There exists an asymmetric relationship between formal credit and vulnerability, and informal credit and vulnerability. The asymmetry explains the lack of borrowing as external credit rationing; farmers substitute formal loans for informal loans. In other words, the problem with credit is institutional, and in such a case, RCC is a likely solution.

1.2: Overview of Kenya's Agricultural Economy:

Agriculture plays a prominent role in Kenya's economy; it takes up 61 percent of employment as well as 29.3 percent of GDP. However, 80 percent of Kenyan farmers are poor in resources and highly vulnerable to the increasing number of weather shocks, such as drought, facing the country (World Bank 2012). As an illustration, twelve droughts were recorded between the years 1970 and 2013, which averages out to one drought every 3.7 years. In fact, that number is expected to rise

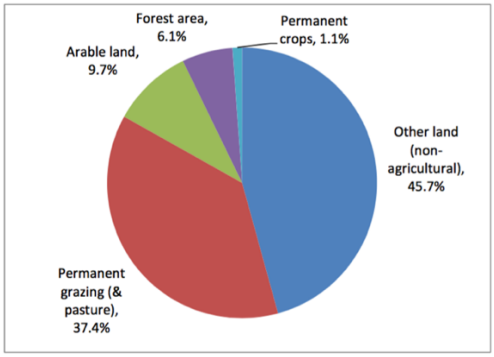
with time as a result of climate change (ILRI 2007, Funk et. al 2010). These events expose farmers to a high level of risk, thus pushing them to rely on low-risk but low-yield farming. Despite the government's attempts at tackling the issue by creating an early warning system for droughts and funding part of the recovery efforts after every weather event, its attempts have been inadequate. The agriculture sector becomes more vulnerable with every weather shock, increasing the need from farmers for social safety nets like insurance.

Private commercial crop and livestock insurers have been reluctant to enter the Kenyan market due to the frequency of droughts and floods. However, there has been a rise in interest from international agencies, although they have yet to be successful. There has been very little uptake of insurance from farmers despite the agencies' best efforts at spreading the word.

1.3 Agricultural Land and Crops:

The following graph presents the different uses of Kenyan land:

Figure 1.1: Different Uses of Kenyan Land



Sources: adapted from World Bank http://databank.worldbank.org, and FAOStat, http://faostat3.fao.org

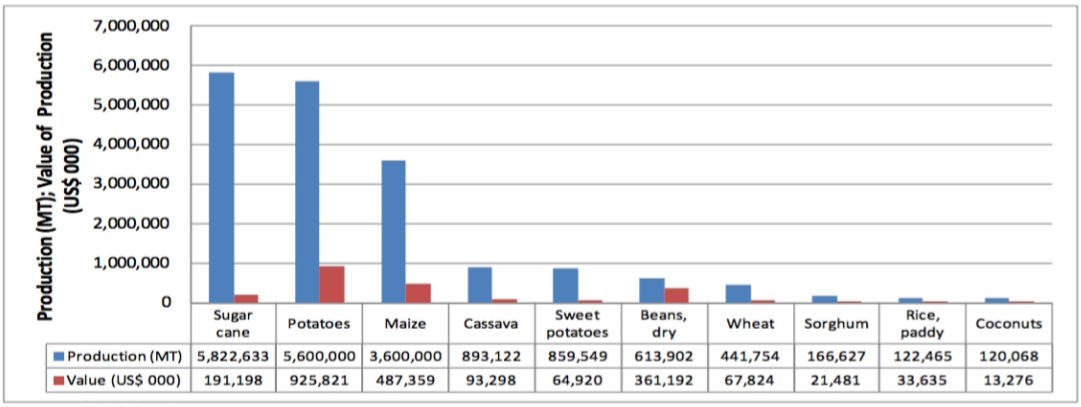
Only 9.7 % of the total land area is suitable for agricultural and it is located for the most part in the Central and South Western regions of Kenya.

Since Kenya's irrigation depends on rainfall, the areas considered arable are those with a high potential for rainfall (above 857 mm) and medium potential (between 612.5 and 857 mm). The agricultural calendar runs from one October to the next. It begins with the short-rains season that

includes planting in October and November, followed by a dry period for harvest in January and February. Then the long-rains season covers March till August, followed by another dry period between August and October.

The food crops planted include most prominently sugar canes, potatoes, and maize. The following shows the top 10 food crops by production and value:

Figure 1.2: The Top 10 Food Crops in Kenya



Source: FAOStat

1.4: Kenyan Farmers:

According to the World Bank, 80 % of farmers are poor in resources:

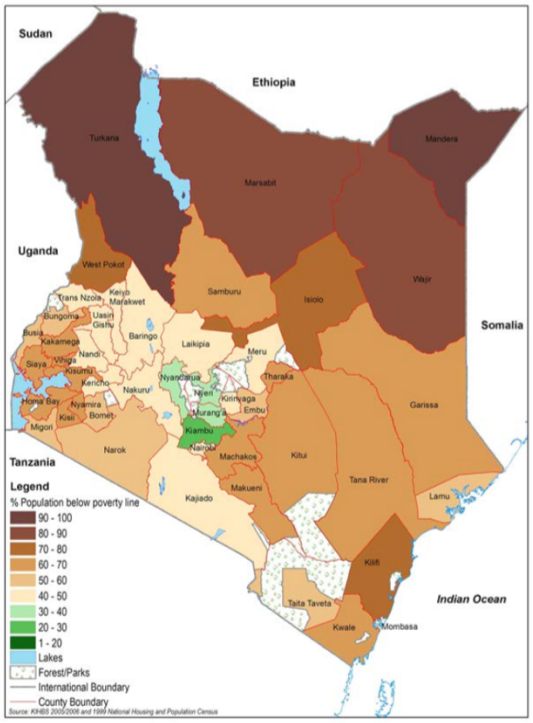
Table 1.1: Typology and Distribution of Farmers

LSM Category	Typology of Farmers	% of Agricultural Population	Agricultural Population (No persons)	No. Farm Households (Million)
LSM 1 -7	Subsistence crop and livestock producers	77.8%	23.12	3.85
LSM 8-11	semi-commercial small crop and livestock producers	16.9%	5.02	0.84
LSM 12 &>	medium and large commercial crop and livestock producers	5.3%	1.56	0.26
Total Agricultural Population, Kenya		**100.0%**	**29.70**	**4.95**

Source: Author's typology of farmers using Synovate LSM distribution and FAO 2011 agricultural population. Analysis assumes average size of farm household = 6 persons.

78 % of farmers, or 4 million households, are subsistence farmers. Commercial insurance is mostly targeted to semi-commercial and medium and large commercial producers, leaving a large segment of the market untapped. Additionally, a large proportion of the population lives below the poverty line.

Figure 1.3: Distribution of Population by Level of Poverty

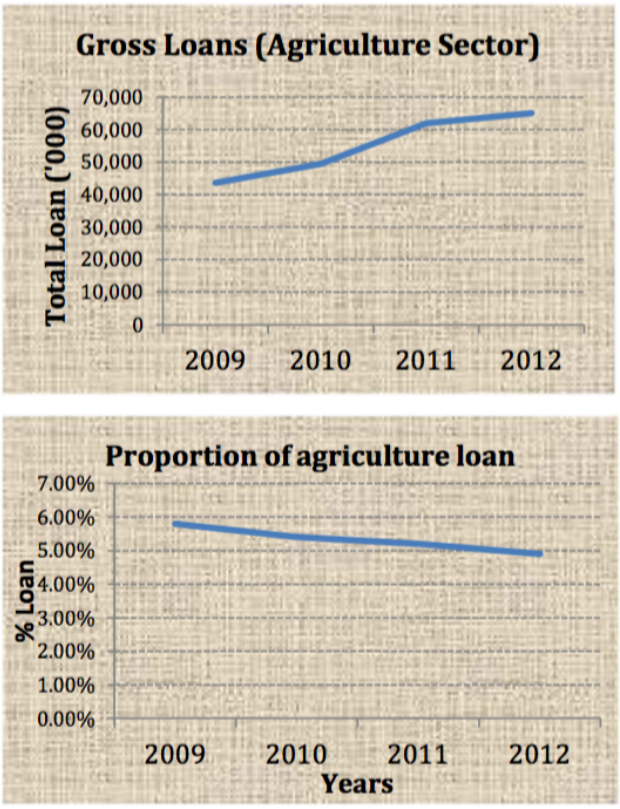


Source: MSPND 2012 (based on KHIBS 2005/06 and 1999 National Housing and Population Census)

Not only do most farmers lack access to insurance, they also lack access to credit. This presents a major challenge. Most farmers function at low productivity levels, as their crop yield falls below potential and is at times on a decline. This is the result of farmers opting for low-yield but low-risk crops. Falling for the poverty trap ensues. Credit could be the key to unlocking that, as it can improve crop yield through access to technology, as well as household income and household welfare.

Yet Kenyan banks and other lenders are reluctant to approach the agriculture sector. The main sources of agriculture credit lending in Kenya are Government Finance Corporations, Equity Bank, and Savings and Credit Cooperatives. But Government Finance Corporations' efforts deteriorated after 1980, while agriculture loans from banks took up only 5 % of lending in 2012.

Figure 1.4: Agriculture Loans in Kenya



Source: Central Bank of Kenya

In addition to weather risk, the challenges facing these financial institutions in providing credit include missing information regarding the agricultural clientele, high transaction costs in rural areas due to poor infrastructure, and collateral limitations. However, this paper finds that the issue extends beyond the availability of credit, since individuals did not take out loans even when credit was made available.

1.5 Objectives and Outline

Given the importance of agriculture in Kenya's economy, and the rudimentary credit and insurance institutions available to Kenyan farmers, this thesis seeks to investigate the degree by which Kenya's agriculture sector is included within the financial sector, and how financial

inclusion translates into usage by farmers. Taking this as an overall objective, the specific objectives of this thesis are to:

1. Analyze the relationship between the usage of credit, savings, and vulnerability in Kenya, and the direction of that linkage.
2. Determine the factors influencing the usage of financial services.
3. Determine the role institutions play on the individual's access to these services.
4. Extend my analysis to Risk-Contingent Credit.

The paper is outlined as follows: chapter 2 consists of the literature review, discussing financial inclusion, Risk-Contingent Credit, and covers the background on credit and insurance. chapter 3 presents the data used in this paper and an overview of the sample. Chapter 4 is the econometric model and the analysis of the results, followed by the conclusion.

CHAPTER II

LITERATURE REVIEW

2.1 Introduction:

I begin this literature review by covering the different aspects of financial inclusion, the core issue in this thesis. I then proceed to an overview of the structure of Risk-Contingent Credit, and a detailed analysis of the concept's evolution and application. The third and final section of this review covers the role of credit and insurance in development.

2.2 Financial Inclusion

In this paper, I am interested in measuring the level of financial inclusion through usage on a household level across Kenya. Financial inclusion is a relatively new concept that is difficult to pigeonhole under one definition. It was introduced by the United Nations in 2005 as a measurement of the financial sector at a micro scale (Jiao and Chen, 2009). It generally seeks to gauge the depth and breadth of financial services.

Financial depth refers to the size of formal financial institutions when compared to the size of the economy. Therefore, financial depth captures the households that are unable to access credit, or that are risk-rationed (Tan 1999; Wu 2005). On the other hand, financial breadth refers to the accessibility to financial services (Beck et al., 2000, 2007a). It is measured using the number of branches and the deposit accounts per capital (Demirguc-Kunt et al. 2011).

Financial inclusion is best understood as a combination of financial breadth and depth, where each of these concepts is crucial in painting the entire picture. However, financial inclusion differs from breadth in its focus on the individual. It can be understood as the ease with which members of an economy can access available formal institutions and can use financial services such as credit

and deposits (Sarma and Pais, 2011; Beck,et al.,2000,2007b). In other words, financial inclusion is a measure of the access low-income groups on the fringes of an economy have to banking services, depending on availability and cost (Dev, 2006). It considers both access and usage, since one does not necessitate the other, and it is believed to encourage growth and development.

According to Beck *et al.* (2007), economies with solid financial depth witness rapid growth and improved income equality, while financial exclusion hinders development. In fact, exclusion may result in continuous income inequality. The authors have also demonstrated that countries with an inclusive financial sector improved the income of the poorest fraction of the economy at a faster rate than countries with a weaker financial sector. Additionally, a large fraction of a country's development can be traced back to the development of financial services.

The specific channel through which financial inclusion leads to growth is still up for debate. Evidence points that it might not be through credit, but instead through a trickle down effect from an increased demand for labor. This is particularly interesting for our research that considers credit a stimulus for growth. In this literature, access to credit does not necessarily lead to a demand or usage of credit (Beck *et al*., 2008). It is therefore crucial to understand the climate of financial inclusion in Kenya, in order to better gauge the factors determining demand for RCCs amongst farmers.

2.2.1 Factors Influencing Financial Inclusion:

In this paper, I am interested in analyzing the variables determining people's demand for credit and savings beyond accessibility, and then proceed to measure financial inclusion's effect on vulnerability.

Similar literature has been rare, but scholars have studied the influences clients' features have on inclusion, in addition to the features of micro-institutions and the environment as a whole. Informal lending between friends and relatives can replace formal credit even when the latter is made available (Turvey and Kong, 2011). As mentioned in earlier sections, collateral requirements can act as a form of hindrance to inclusion. Finally, household characteristics, such as age, level of education, and the gender of the household head, have been proven empirically to affect access to financial services (Turvey *et al*., 2011). They are therefore controlled for in my model in later chapters.

Additionally, the lack of financial education can hinder the usage of financial services. A study of rural China found that the rural community relies on online banking half as much as other users, and this community barely accesses credit electronically (Turvey and Xiong, 2017).

From an institutional perspective, financial products are relatively homogenous since services come at a high cost. As a result, the products are not tailored to the different financial needs of livestock farmers or crop growers, which results in a mismatch between supply and demand of services (Huang et al., 2009).

On a broader scale, factors hindering inclusion include a lack of supply of services such as loans, where rural deposits are used for loans in urban areas (Han, 2009). High transaction costs and a lack of competition in the sector also factor in. These issues relate to the over all environment, such as differences between banks in rural areas and urban areas, (Zhu *et al.,* 2010) as well as the risk measures taken (Han, 2009).

2.2.2 On Financial Inclusion and Development:

Beck et al. (2000) analyzed empirically the linkage between development of financial intermediaries and economic growth, as well as the growth of GDP per capita, capital per capita, productivity per capita, and savings rates. The approach is generally from a macroeconomic perspective, yet variables like the savings rate are of particular interest in this paper.

The authors find that the development of financial intermediaries has a clear positive impact on GDP and factor productivity growth. The channel through which this occurs is the faster pace technological and production growth adopts with improved intermediaries. The results are less clear regarding the effect of intermediaries on savings and physical capital growth. In fact, the authors indicated that any impact intermediaries had on the savings rate was minimal. However, over all, improved intermediaries lead to an improved allocation of resources and stronger economic growth in the long run.

Methodologically, the authors determined a simultaneity bias between the growth of intermediaries and the other measures of growth. This is relevant because, in this paper, I control for the endogeneity resulting from the simultaneity occurring between credit, savings, and vulnerability. In Beck's paper, the authors relied on an instrument, the legal origin of the countries, to control for this bias. This was possible since their analysis was across multiple countries.

Beck *et al.* (2005) offered the first empirical analysis of the positive relationship between economic development and the access and usage of financial services. It a more micro-level analysis as it relied on firm-level data. Although access to services did not guarantee usage of services, their findings did indicate that as financial hurdles dropped, a larger usage of banking and loan services was observed.

The authors measure financial access using data on the intensity of bank branches in geographical areas, and they measure usage based on the number of deposits and loans relative to GDP per capita. Although these are good predictors, these measures do not control for the multiple services used by one individual, they do not factor in informal institutions into their analysis, and they do not measure individuals' reporting of usage.

The results indicate that economies of scale help the outreach of banking services. In addition, government-owned banks exhibit smaller financial penetration. And finally, improved system of communication regarding the benefits of services lead to better outreach.

Financial development also has an impact on income inequality. Development reduces inequality, and it disproportionately aids those in the poorest quintile. Beck *et al.* (2007) estimates that 40 % of the income growth of the poorest is the result of a drop in inequality. Additionally, development speeds up the reduction of the poverty in populations. The policy suggested by the authors entails applying reforms to the financial sector as it results in economic growth. Innovations such as the Risk-Contingent Credit piloted by the SATISFy project supporting this thesis follow the same logic in providing new financial services to alleviate the risk of poverty and promote growth.

2.3 SATISFy Project

As mentioned earlier, this research seeks to provide a stronger background on the relationship between financial services and the people in Kenya as part of the SATISFy project, which will introduce RCCs into Kenya's financial market.

2.3.1 Overview of Risk-Contingent Credit:

The main deterrent for development in Sub-Saharan Africa is the absence of credit due to uninsured risk. Uninsured risk diminishes small farmers' productivity and agricultural development. In addition, insurance is also lacking despite proven need for it. Carter, Cheng, and Sarris (2011) demonstrated that credit and insurance cannot survive as separate entities. Both are in high demand and they recommended that both be interlinked. In a low collateral environment, uptake of collateral improved only when insurance was interlinked with the loan. Meanwhile, in high collateral environments, farmers were risk-rationed when insurance was missing, and little credit was adopted. When interlinked insurance was available, the collateral requirements were strongly relaxed by lenders. The authors therefore predicted that government subsidies could be applied in the final scenario.

Similarly, we believe Risk-Contingent Credit (RCC) can be the product that unlocks farmers' access to credit through its linkage with insurance, leading to improvement in farming, income, and finally welfare. Risk-Contingent Credit (RCC) is a structured financial instrument with a built-in insurance on – in this case – weather and rainfall (Shee and Turvey, 2012; Shee, Turvey, and Woodard, 2015). When triggered, RCC transfers part of the loan borrower's liability to the lender, therefore alleviating the borrower of the risk of default. It could be any credit instrument with an embedded contingent claim, and in the SATISFy project it is a put option on future rainfall imbedded within a traditional loan. The option meets the bank's collateral requirement, and it is designed with a premium interest along with the loan interest rate. The premium interest depends on the volatility of the underlying risk.

The issue facing farmers put simply:

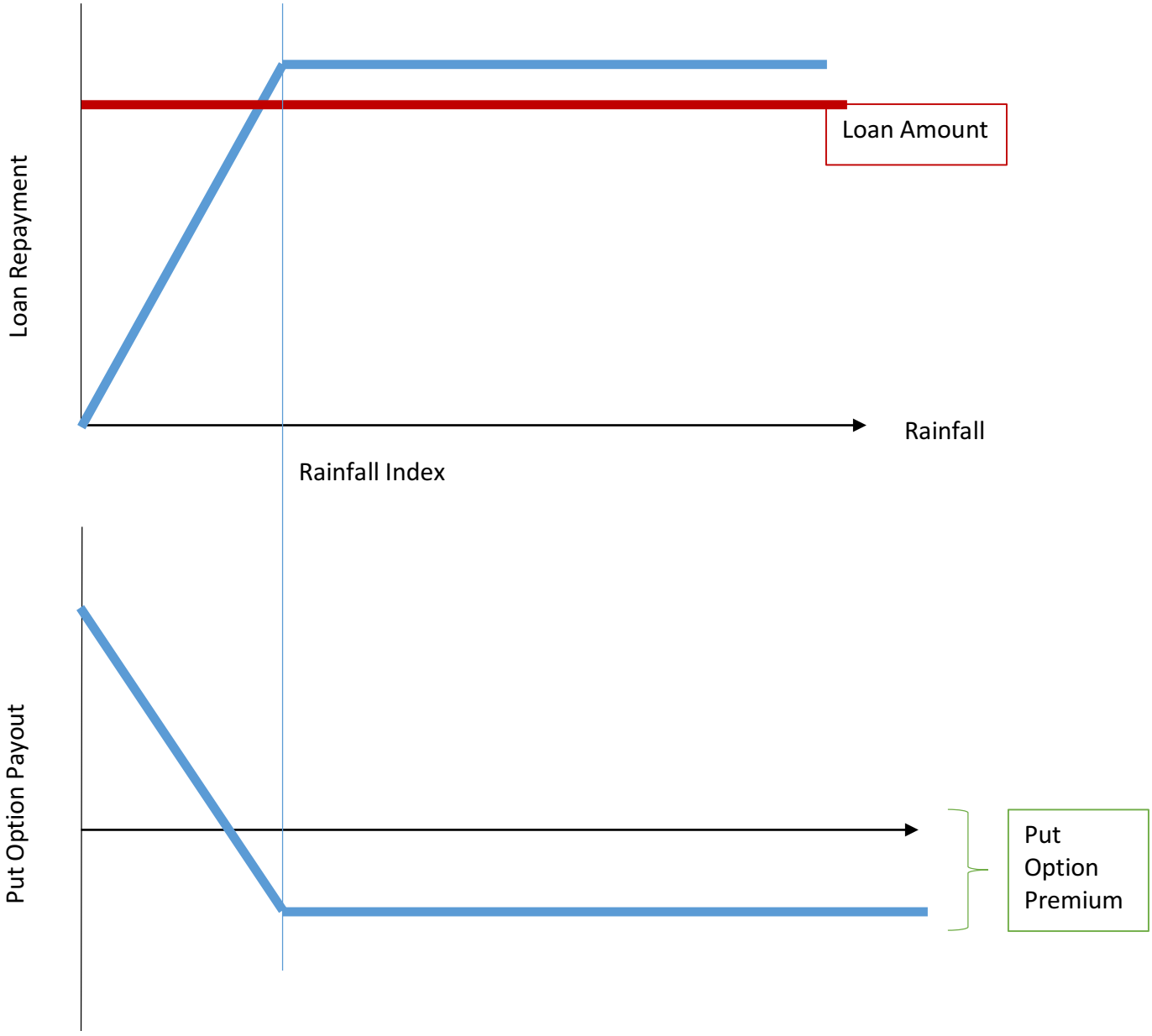
Seasonal rainfall falls below a predetermined threshold causing a drought. What ensues is a shortage in crop yield. This results in a drop in income for farmers, who become unable to pay back the full loan amount. They are therefore at risk of losing their collateral.

Farmers long the put option with the loan at a premium and receive the loan upfront. The put option is triggered when rainfall fails. If rainfall falls below the blue line threshold in the figure below, the option acts as a form of insurance against risk of default, since it helps repay the portion of the loan amount the farmer is unable to pay back. The farmer's repayment obligation falls linearly as rainfall continues to drop. RCC's payments are directed strictly towards the loan account. It therefore guarantees repayment of loan and creates lending that is "collateral-free". If rainfall remains above the threshold, the farmer must pay back the entire loan along with the RCC premium interest.

The loan is linked to insurance which has the characteristics of a put option to hedge against the risk of a drop in rainfall. It mimics an RCC for a drop in crop prices for example. However, the option linked to the loan would be a call option if the farmer were to manage the risk against excessive rain.

RCC's interest rate takes into account the indemnified risk, which makes it higher than the rate on a regular loan. Borrowers ought to be indifferent between the rate on RCCs and a rate on an operating loan with collateral requirements.

Figure 2.1: The Mechanics of RCCs



Benefits of RCCs to subsistence and small farmers:

(1) Eliminates collateral risks and improves repayment ability in case of drought.

(2) Credit improves access to technology which helps scale up production.

(3) Farmers grow resilient since RCCs hedge against risk during production.

(4) Farmers with low liquidity can afford insurance since payments will not be made upfront.

(5) Unlocks poverty trap and welfare increases.

(6) Agricultural development occurs in the long run.

The benefits to financial institutions are:

(1) Agricultural lending much less risky.

(2) Collateral requirements will drop or be eliminated. More farmers can become clients.

(3) Broadening scope of lending by including the agricultural sector, since risk of default drops drastically. Credit availability depends on risk, such as that of weather, which is controlled for.

2.3.2 Project Design

This thesis is prepared separately from the implementation of RCCs which will take place at the start of the crop year in September of 2017. Nonetheless, in order to place this thesis within the overall context of the SATISFy project, I will provide an overview of the project's goals.

The delivery of RCCs to Kenyan farmers is set up as a Randomized Control Trial in order to isolate the treatment effect of RCCs and eliminate any systematic differences across participants. It will take place in Machakos and will involve a sample of 1080 households. The sample size is this large in order to avoid committing both a type 1 and type 2 error within the analysis.

The farmers chosen are interested in seeking a loan for agricultural purposes, and they meet the bank's loan appraisal process. Equal number of households are picked from every village. This sample is divided into equal number of control and treatment households from every village. This controls for any systematic difference across villages and communities.

The project opts for individual randomization instead of clustered since it assumes RCCs will not lead to competition. In addition, the current sample size would only allow for small clusters, and treatment occurs only at the household level.

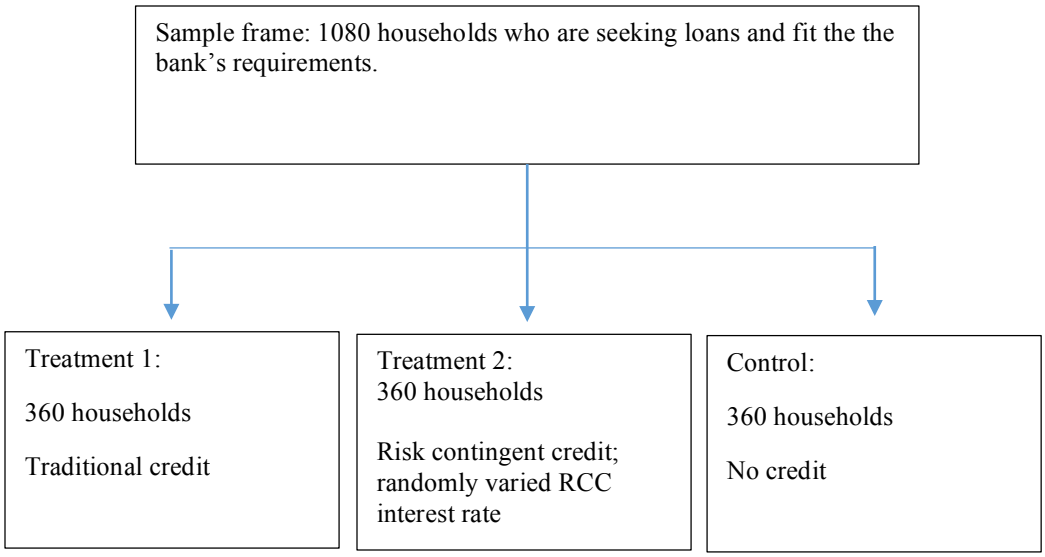
In order to control for any resentment between participants, the randomization will take place as a public lottery with Equity Bank.[1] The sample of 1080 households will be divided into three groups:

(1) Control group: 360 households who receive no credit.

(2) Treatment group 1: 360 households who receive traditional credit.

(3) Treatment group 2: 360 households who receive RCCs with different interests.

Figure 2.2 The Sample Groups



The project expects the impact pathway to go as follows:

(1) Farmers face drought risk and lack access to credit.

[1] Equity Bank retails RCCs as its own product. The insurance component will be underwritten by a local insurer and reinsured by Swiss Re. For the first year, pilot loan amounts will be limited to $ 120 and will be secured by funds on deposit by the SATISFy project and IFPRI.

(2) A drought index is set up for the RCC, and personal information on farmers are collected. The information covers their farming situation, household characteristics, level of resilience and risk aversion.

(3) Risk Contingent Credit is implemented along with Equity Bank.

(4) Uptake leads to improvement in crop production. Access to better resources leads to production at lower risk and with better technology.

(5) Household income and welfare increase. Resilience against shocks improves.

As a first step, eligible farmers are selected, and they are surveyed by a partner, Tegemeo, before the lottery begins.

2.4.1 On Credit and Index-Based Insurance:

In the absence of insurance, rural farmers resort to informal mechanisms to insure against shocks. However, these mechanisms come at the expense of profitability, and hinders the adoption of advanced and profitable farming practices. Their income ends up lower than it would have been had insurance been available.

In Rosenzweig and and Wolpin's (1993) paper, the authors analyzed the impact of imperfect financial markets on the risk management and consumption smoothing of farmers. They examined farmers' investments in bullocks, one of the main production factors in India and one of the main non-asset holdings. When encountered with shocks, farmers prioritized consumption smoothing and sold the bullocks, at times at low prices. These sales jeopardized the future income of farmers. In other cases, such as that of China, evidence indicated that farmers valued income smoothing. In order to hedge against the risk of shocks, they therefore grew less sow when provided with only inefficient insurance. (Jalan *et al,* 1999) These scenarios demonstrated how ineffective informal

mechanisms were in allowing for productivity, growth, and in preventing the poverty trap, and they encouraged access to insurance and credit.

In fact, the literature predicts that demand for insurance and credit in developing economies is high. According to Murdoch (1995), in markets with proper insurance and credit, shocks will not affect households' consumption, since borrowing and savings can smooth away the risk. Farmers in those markets would not alter their production methods.

On the other hand, in markets where farmers face barriers against these services, risk aversion ensues. Farmers resort to conservative farming techniques. Binswanger and Rosenzweig (1993) demonstrated that vulnerable households shifted their production into less profitable territories. For example, households at the lowest level of income would lose around 35 percent of their profit as a result of income smoothing. Therefore, interest in insurance and credit grew.

Index-based insurance is the most revered form of insurance. Interest in index-based insurance began after individual assessed insurance was disregarded. Hazzell *et al.* (1986) exposed the flaws of claim-based agricultural insurance, which was initially thought to be the best type of safety net. This insurance program was too costly since it required individual assessment of damage. Additionally, there was a risk of asymmetry with information between the buyer and the seller, as well as moral hazard. Other difficulties included heterogeneity of farms and crops, and the risk of insurers failing to provide enough liquidity to cover significant weather shocks that spanned regions.

Index insurance refers to indemnity payments that depend on thresholds set through an underlying index. Index insurance could target area crop yield or rainfall. It is especially convenient for poor regions which lack access to regular insurance since it lowers the transaction costs behind assessing losses. (Chantarat et al, 2009) Additionally, index-insurance eliminates

moral hazard – since indemnities depend on regional indices, and transfers insurance companies' risk to the international market. Insurance companies could be reinsured since insurance is based on a legitimate index.

Index-insurance should also lower basis risk. Basis risk refers to a low correlation between individual losses and the index, which increases the risk of one's losses going uninsured. It decreases since one contract can be linked to multiple weather stations (Norton *et al*, 2015). Basis risk therefore reduces insurance demand, and lowers demand elasticity. (Marr et al, 2016) The benefits of index-insurance when taken on its own (i.e. not linked to anything) include diverting investment into riskier but more profitable crops. It also diminishes credit rationing, and improves farmers' welfare, particularly the poor. (Marr et al, 2016)

To create such an agriculture insurance program, Belanger (2016) created a general roadmap consisting of 13 concepts crucial to rendering the program successful.

Figure 2.3: The 13 Concepts to an Insurance Program

Fundamental Concepts
1- Think long-term: insurance takes years to develop correctly
2- Understand the risks
3- Insurance should complement other risk mitigation actions
4- Without demand there is no program
5- Multiple ministries should be continually engaged
6- Laws, regulations and policies transcend politics
7- Include reinsurers early
8- No single insurance product is a panacea
9- The devil is in the details
10- Government and private sector collaboration strengthens the program
11- Develop government technical expertise
12- Be self critical, constantly evaluate and implement best practices
13- The turtoise wins the race

Based on Hatch et al 2013.

Our project has abided by many of these concepts:

(1) Think long term: Setting up the baseline survey began in October 2016, although managing the details of the product with Equity Bank dates back to before that. The pilot is expected to end in April 2018, only after which enough information is gathered to set up and release the product.

(2) Understand the risks: Through town meetings in different villages, members of the project met with farmers to understand the types of shocks they were most vulnerable to. It turned out weather shocks, and drought in particular, were the main sources of risk with crop farming. In addition, NDVI data, historical yields, and drought shocks data were gathered to corroborate those claims.

(3) Without demand there is no program: During the town meetings, farmers expressed interest in the product. In addition, Shee, Turvey, and Woodard's field games in Kenya demonstrated farmers' interest in the product. The main purpose of this paper is to quantify and gauge the farmers' interest.

(4) Multiple ministries should be engaged and laws; regulations and policies transcend politics; government and private sector collaboration strengthens the program: The project goes in line with Kenya's Vision2030 project for long term development. It helps in achieving economic growth and social development.

(5) No single insurance product is a panacea: Farmers in Kenya grow fruits as well as maize and corn in the same field. The insurance product is therefore being tailored to cover the different types of crops based on an index, and the rates will also differ based on season.

(6) The devil is in the details: The product's mechanism is simple, and volunteers are traveling to villages in order to properly explain how RCCs work to farmers.

(7) Be self critical: This stage of the project is a pilot. Its purpose is to assess what we are providing and tweak accordingly.

(8) The tortoise wins the race: As mentioned earlier, the project is moving at a cautious pace but for good measure. For example, after the Haitian earthquake in 2010, a rice insurance pilot, Systeme de Financement d'Assurances Agricoles en Haiti (SYFAAH), was launched in order to improve farmers' yields. At first, only 149 farmers were insured. But between 2014's second cropping season and 2015's first, there was 171% increase in the number of farmers insured. (Belanger, 2016).

Yet, even after a proper creation of an agriculture insurance product, adoption has been low. According to Marr et al (2016) (adoption and impact of insurance) demand has ranged from 2 to 40 %, and at times at less than 0.25%. One of the main culprits is credit constraint. As an example, Gine *et al*. demonstrated credit constraint's negative effect on the uptake of index insurance. (2008) They analyzed the uptake of an inexpensive rainfall insurance product that provided a payout to farmers during the three phases of the monsoon season in southern India. It was provided by BASIX, a microfinance institution. One of the main reasons for not purchasing the insurance was a lack of sufficient credit, as 21% of respondents had reported. Additionally, their probit model showed that credit constraint negatively affected the uptake, and the estimator was significant at the 1 % level. The authors then recommended that the insurance be paired with a loan in order to help these respondents. In other words, they encouraged microcredit as a solution to the problem.

2.4.2 Credit and Insurance:

It has been shown that access to credit increases willingness-to-pay and take up of insurance (Marr *et al*, 2016). In Carter *et al*'s model (2011), the authors found that wealthy farmers with high collateral were risk rationed and therefore did not borrow unless insurance was available. That was the result of lower default rates. On the other hand, farmers with low collateral were said to be price rationed and borrowed only when interest rates were low, and stand alone insurance did not alter their behavior. Carter argued that interlinked contracts encouraged farmers with both low or high collateral to adopt high technology practices in their farming.

Better technology leads to higher consumption rates in the long run, while households with traditional technology lag behind. Although providing credit and insurance separately has exhibited larger take-up than when they are interlinked, a bundled product, such as contingent credit, has exhibited lower default rates (Farrin and Miranda, 2013). As a result, these contracts encourage lenders to supply more credit and lower quantity rationing. Another determinant of lower default rates is whether the bank is the initial receiver of the indemnity payments. Farrin and Miranda (2013) studied two scenarios; one where the borrower received the indemnity first, and another scenario where the bank was the first to receive it. In the first scenario, the indemnities improved the household's disposable wealth, which increased the likelihood of default and therefore the lender's risk. However, when the bank received the indemnity first, such that the insurance was a form of contingent credit, default was much lower. Therefore, contingent credit is most reliable since it encourages adoption of technology while controlling for risk of default.

However, bundling insurance and credit in all its forms was contested by Karlan *et al* (2014) The authors assigned Ghanaian farmers either cash grants, rainfall insurance grants, or both together. They found a strong response to the insurance grant and little response to the cash grant.

In addition, the farmers who received both invested the same as those with just insurance. These results highlighted the hindering role uninsured risk played in investment decisions, while it diminished the importance of liquidity constraints since farmers managed to find credit and cash investments once they were insured.

2.4.3 Evolution of RCCs:

Many developing countries have relied heavily on one or two commodities for their earnings, which has rendered them vulnerable to changes in price. Between 1931 and 1982, this issue was addressed on a broad market scale through the International Commodity Agreements (ICAs), which raised prices across markets whenever there was a slump. However, ICAs died due to difficulties in setting prices, and focus shifted towards risk management at an individual level. For example, there was an increased interest in the futures market, since, as Morgan (2001) documented, it could provide producers anticipatory hedging and price support at a premium. Morgan proceeded to demonstrate that producers in developing nations lacked access to commodity futures since domestic exchanges were unavailable. But the high level of adoption of commodity futures by producers in developed nations signified that there was a high demand for such a product to manage risk, only when it was available though.

RCCs represent the latest efforts in targeting individual producers for risk management. The concept itself is relatively new but not uncommon. The earliest mention of such a product was in 1986, when banks in the Philippines and India were required to increase their loans to the agriculture sector up to a certain percentage. In order to minimize lenders' risk of default, either a government agency guaranteed to reimburse part of the loan, or an intermediary offered crop insurance that managed reimbursement when crops got damaged. However, this project was

flawed as it required the government to pay large subsidies, and a large staff was required to verify the crop damages (Adams *et al.,* 1986).

Skees and Barnett (2006) introduced the concept of Index-Based Risk Transfer Products, which could be structured as options to transfer risk across multiple parties. The challenges it faced were the high costs to reach farmers in rural areas, and the basis risk inherent within it. It was applied in areas like India, where the MFI was retailing insurance on rainfall, while relying on risk-transfer products against risk of default. In Mongolia, the government introduced a livestock insurance for herders. If mortality rates of livestock rose beyond 7 %, herders received payments covered by both the government and the insurer. But the product was not tied to lending. Other examples included risks in Peru related to El Nino.

Theoretically, structuring the precedents of RCCs could be traced back to Schwartz in 1982 as he presented an option pricing theory. In 2002, Jin and Turvey followed up by discussing these commodity-linked bonds and the potential for adoption in agriculture. They described the product as a debt instrument contingent on the outcome of commodities. Aside from the commodity-linked mortgages offered by Canada's Farm Credit Corporation, few known applications of such a product were available to farmers. The authors proceeded to develop a theoretical pricing model based on Schwartz's using real data and Monte Carlo simulations. They concluded that the product can reduce financial risk – or degree of leverage - when faced with business risk - volatility of return on assets. The purpose of the paper was to encourage applying the model on mortgages and amortized loans with farmers.

Later, Shee and Turvey (2012) conducted a simulation in India which addressed market and pulse crop price risks facing farmers, and they set up the structure for RCCs. Despite efforts from the Indian government to encourage lending, crop price changes had led many to default on their

loans and lose valuable fixed assets. RCC can control for credit rationing that naturally ensued, and it can help lift credit caps from formal lenders. In the paper, the authors balanced out in their design the lender's tradeoff between collateral and higher interest rates. The borrower must decide between taking a loan at a higher interest rate with a similarly large chance of default, or a lower interest rate with an increased likelihood of losing collateral. But RCCs transfer the risk of default on a third party. Through their simulation and using real data on various pulse crops, the authors proved that the premium interest rates of the RCCs changed with volatility of the commodity. The higher the volatility, the higher the risk, the more compensation was required by the lender. They also concluded that it provided protection on downside risk for these farmers on crop revenue. Additionally, RCCs can improve minimum income.

2.4.4 Applied Research on RCCs: Case Studies

Gine and Yang's (2009) field experiment with insured loans in Malawi was one of the few applications of a product that strongly resembled RCCs. They addressed the market imperfection where uninsured borrowers avoided taking loans due to risks of default. They sought to encourage farmers to adopt an advanced high-yielding yet risky hybrid maize and groundnut seeds in order to stimulate development. They randomly divided 800 maize and groundnut farmers into two groups: a control group that is offered a loan for such seeds without rainfall insurance, and a treatment group that is offered a loan with insurance in case rainfall failed. The authors had anticipated that the insured loan would be more effective in encouraging the risk-averse farmers to adopt these seeds. Yet the take-up of the insured loan was surprisingly much lower than that of the uninsured. The explanation they offered was related to the *implicit* insurance embedded in the uninsured contract. If a farmer's income is low enough, it limits his/her liability, and he/she would

opt for the uninsured loan instead of the hybrid seeds. The explicitly insured loan is too expensive, and the farmer will grow regular seeds instead. As for the farmers who took up the insured loans, education and wealth were key positive factors. Yet those factors were insignificant with uninsured loans.

Another application was a pilot experiment in rural Ghana by Karlan, Kutsoati, McMillan, and Udry (2011). The main reason farmers in Ghana were refraining from taking loans was reported to be the volatile crop prices. Through a randomized trial, 50 % of farmers were offered a loan that included at no added cost an indemnification on crop prices; if prices fell below a threshold, borrowers were relieved of paying back half the loan. The other group was offered a traditional loan. There results showed no significant difference between groups on take-up. In fact, if farmers were expecting crop prices to fall, they were *less* likely to take up the indemnified loan. This was possibly due to pessimism regarding the treatment loan. In addition, farmers who took up the indemnified loan did not exhibit higher investment in inputs. The authors offered few explanations; either the banks were already lenient on default, or prices were more stable than initially thought. Clearly, more research needed to be done.

In Kenya, Shee, Turvey, and Woodard (2015) conducted field studies across counties through field games involving RCCs. The games were there in order for the authors to gain insight on risk, credit, and potential for research and product development. What the authors found was that there was a high interest and demand for RCCs across all groups from all counties. They all exhibited a willingness to pay the premium in exchange for the benefits RCCs provided, especially when addressing their different problems.

2.4.5 Theoretical Models:

The first step is to analyze the financial and business risks of small agricultural businesses with high income volatility as a result of weather instability.

$$E(ROE) = E(ROA)\,(A/E) - i\,(D/E) \qquad (2.1)$$

E(ROE) is the expected return on equity, and this equation represents its relationship with expected return on assets (ROA), as weighted by assets (A), equity (E), and debt (D). By setting this equation equal to zero, we can derive the breakeven ROA:

$$ROA^* = i\frac{D}{A}. \qquad (2.2)$$

Critical ROA could be considered a definition of financial risk. It is the probability boundary below which operating income falls short of satisfying financial obligations. Therefore, financial risk is the risk that return on asset falls below the critical value:

$$PROB(ROA < ROA^*) = \int_{l}^{i(D/A)} f(ROA|p,x)dROA. \qquad (2.3)$$

Should the interest rate and/or debt to asset ratio increase, the financial risk increases as well. To reduce this risk, hedging with options lowers the probability in the lower tail. (Turvey et al, 2012)

Since the price of the RCC can be fully hedged, it can be priced using simple equations. Farmers require operating loans which they can pay back after selling what they have harvested. Therefore, the present value of a traditional operating loan without an imbedded option can be written as:

$$B_1 = e^{-iT} f e^{(i^{**})T}. \qquad (2.4)$$

where f is the borrowed amount and i is the discount rate.

On the other hand, our RCC is an operating loan contract with a commodity option embedded onto it in order to insure against farmers' repayment abilities. Its present value can be written as:

$$B = e^{-i*T} - \psi[Max(0, Z - R(T))]) \qquad (2.5)$$

where Z is the strike price, P(T) is the price of the commodity at time T, and

$$\psi = \frac{f}{Z - R\ (T)} \qquad (2.6)$$

By equating both equations to each other, $B=B_1$, we can derive the interest rate for the loan with an embedded insurance:

$$i^* = \frac{\ln[\frac{\psi\ E[Max\ (0, Z-R(T))]}{f} + e^{(i**)T}}{T} \quad (2.6)$$

where *E*[Max(0, *Z-R(T)*)] represents the put option's value. i* is referred to as the risk-adjusted interest rate, and it comes at a premium when compared to that of a traditional loan (Shee and Turvey, 2012).

2.4.6 Remote Sensing:

The index for rainfall determining when the RCC will be triggered will depend on the Normalized Difference Vegetation Index (NDVI). NDVI is a satellite measure of greenness of vegetation on the surface of Earth. (Turvey et al, 2012) NDVI gives a unitless value ranging from -1 to 1 to determine the health of the vegetation. As soil improves from bare to healthy, the number increases. NDVI data is data that is provided in real time, which is crucial for determining when and if the put option gets triggered. In this project with this product, the NDVI data relied upon covers rainfall, temperature, as well as soil moisture.

When it comes to remote sensing, its uptake in private insurance has been generally low, mostly due to a lack of understanding of its potential uses. (De Leeuw et al, 2014) Unlike claim-based insurance where premiums are determined through historical data, index insurance allows a lot of room for remote sensing adoption, such as NDVI.

Index insurance refers to indemnity payments that depend on thresholds set through an underlying index. Index insurance could target area crop yield or rainfall. It is especially convenient for poor regions which lack access to regular insurance since it lowers the transaction costs behind assessing losses and the risk of moral hazard from claim-based insurance. (Chantarat et al, 2009) NDVI offers index insurers verifiable information, that are available in real time and are not costly, and can act as the bases for setting up the underlying index. It could then potentially lead to index insurance widening its spread of the market and at a lower cost. However, it is unclear if it can lower the basis risk inherent in index insurance. Index insurance does not cover loss on an individual level if market-wide loss isn't observed. It is unclear if NDVI can control for that since continuity of data is not certain. Additionally, the farther the farms are from the weather station, the smaller the correlation between data and crops.

However, on the crop insurance level, the trust in NDVI grows even murkier. For example, in Zimbabwe, Makaudze and Miranda (2010) found the correlation between NDVI and growth of crops to vary greatly according to district location and type of crop. Turvey and McLaurin set out to study NDVI's application through case studies across different locations. They found a large variation in the correlation between NDVI and precipitation. Similarly, the relationship between NDVI and extreme heat, as well as vegetation conditions, was very unstable across locations. Yet that is not to say that correlation between NDVI and rainfall, as well NDVI and extreme heat, renders NDVI unusable. NDVI can be put to good use in small regions for rainfall, and in particular

regions, it is a great measure for extreme heat. It is effective in areas that are mostly grasslands and pastures. In fact, the authors do clarify that NDVI has proven to be effective in certain projects, and these flaws do not disqualify it from its potential uses.

For example, an ex-ante assessment of an Index Based Livestock Insurance (IBLI) in Kenya proved the product could be quite successful but under certain conditions. (Chantarat et al, 2009) The study investigated the performance of IBLI in Northern Kenya through simulations. In Northern Kenya, livestock represents households' wealth, and therefore livestock mortality poses the greatest risk to households' financial prosperity. IBLI indemnity payments are triggered according to livestock mortality rates relative to pre-specified thresholds.

The simulation showed that IBLI works best for the vulnerable non-poor households. It also found demand to be quite price elastic, and the authors therefore recommended partial subsidization in order to protect those vulnerable of falling into a poverty trap.

2.5 Chapter Summary

Financial inclusion is a relatively recent concept, and yet the literature has repeatedly demonstrated its positive impact on the welfare and growth of an economy. Although the literature on the impact of the usage of financial services on an individual is scarce, certain household and institutional characteristics have surfaced as clear determinants of demand for such services.

With the regard to Risk-Contingent Credit, there have been attempts at implementing similar products, yet they have not been successful. That being said, I demonstrated that the literature on the crucial role of credit and insurance in development is excessive and definitive.

CHAPTER III

DATA

3.1 Introduction:

In the previous chapter, I reviewed the conceptual basis of financial inclusion and the relationship between financial inclusion and the goals and objectives of the SATISFy project. The relationship between financial services, consumption, and vulnerability was discussed, and the means and methods of implementing RCCSs on a pilot basis was reviewed.

The focus on financial inclusion in this thesis is a precursor to the baseline survey and implementation of the RCC product outlined in the SATISFy project. That works begins in May 2017, as this thesis was being completed.

The thesis is taking a broader view of Kenya with the aim of identifying key economic relationships and analyzing the difference between farming and non-farming households. To achieve this objective, I use the individual responses to the World Bank Global Financial Inclusion survey in Kenya (Demirguc-Kunt, Klapper, 2012). This data is used in the regression models that follow. This chapter describes and summarizes the data.

3.2 The Global Financial Inclusion Database:

The cross-country data captures the different measures participants take in managing their finances with the available institutions. In Kenya, it consisted of survey data with a thousand randomly selected participants age 15 and above. The dataset itself has been used internationally, encompassing 148 countries, ranging from high income to low income economies. (Demirguc-Kunt, Klapper, 2012)

The data is considered a tool to help provide empirical evidence for policy-makers to help facilitate their decision-making. It can be used to feed into the scarce literature connecting financial access and development. This dataset is particularly helpful since it clearly compartmentalizes population segments into income quintiles, therefore easily identifying the poor segments of an economy. Additionally, it captures financial penetration and usage at an individual level, which deflates the numbers otherwise generated by a household level dataset, since the latter does not factor in women and youth.

The data was collected through face-to-face interviews in countries where telephone coverage reaches less than 80 percent of the population. Individuals are selected randomly through random route procedures, and they are required to be noninstitutionalized civilians (Demirguc-Kunt, Klapper, 2012).

3.2.1 Survey Description:

The survey details different aspects of participants' usage of services. Participants cover all income quintiles, and they include both farmers and non-farmers. The survey determines whether these participants have accounts at institutions, and whether they have used services such as debit or credit cards, and their reasons behind it.

It continues by following their account deposits and transactions, their savings, and also their reasoning. It follows suit with similar questions but for credit, while determining whether loans are taken up from formal or informal sources. The questions also detail whether participants receive wages through farming or different forms of employment. Additionally, participants determine their perception of their own risk and how they would manage it.

The survey does involve a tangential segment on mobile and online banking, but these answers are not particularly relevant for this study.

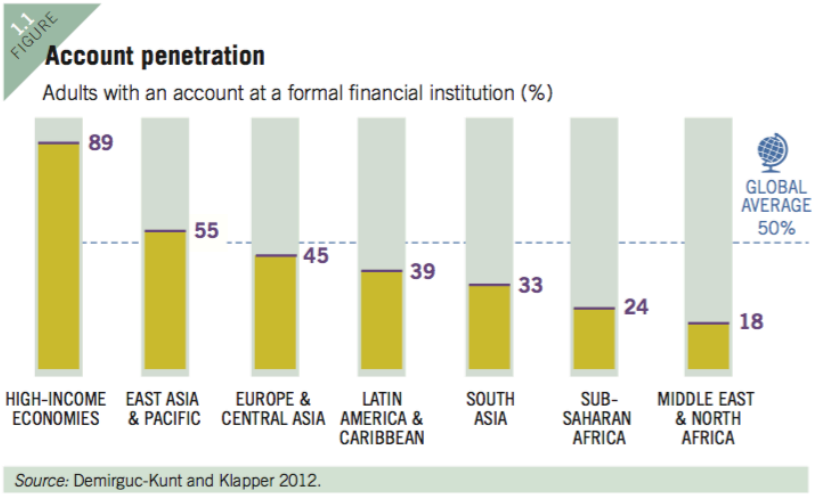
3.3 Overview of Financial Access Internationally:

It is estimated that 2.5 billion adults do not have an account at a formal financial institution globally, most of them in middle and low income economies. A mere 41 percent of adults in developing countries have an account, while 89 percent in high income economies do (Demirguc-Kunt, Klapper, 2012).

Economies with high GDP per capita exhibit the largest account penetration, yet national income does not explain certain trends in developing areas. For example, developing countries face a clear gender gap, as 9 percent more men than women have a formal account at an institution (Demirguc-Kunt, Klapper, 2012). Adults in the top 20 percent income quintile of those countries are twice as likely to gain access to those institutions than adults in the poorest quintile. Most commonly cited barriers for access in developing areas include cost of services, distance from institutions, and the paperwork required.

Internationally, access to accounts, and therefore institutions, looks as follows:

Figure 3.1 Account Penetration Across Areas

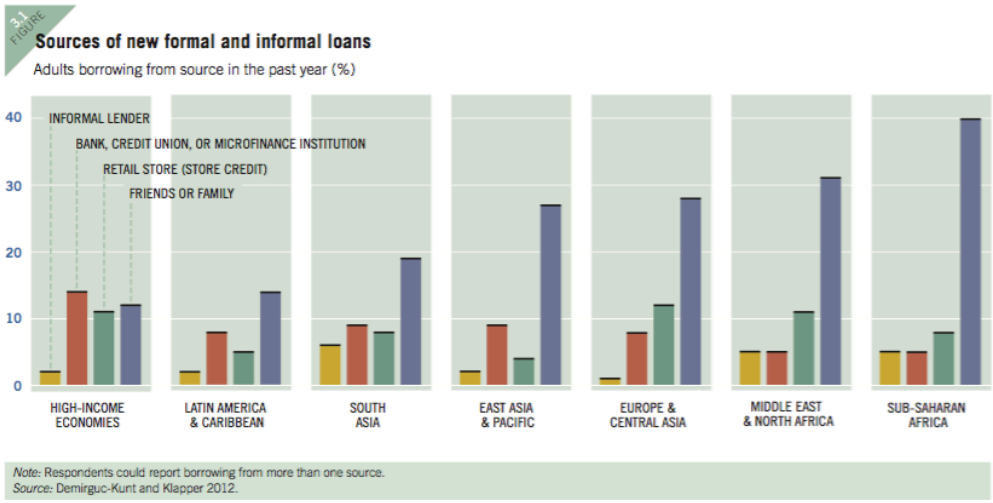


As expected, the main area of interest in this thesis - Africa in general and Kenya in particular – is represented on the lower end of the spectrum.

With regards to credit, 14 percent of adults in high income countries have taken out loans from formal institutions, while that estimate drops to 8 percent with adults from developing areas. Similarly, most adults would resort to informal loans in case of emergencies in developing areas (Demirguc-Kunt, Klapper, 2012).

The following graph represents the different forms of lending internationally:

Figure 3.2 Sources of Lending Internationally

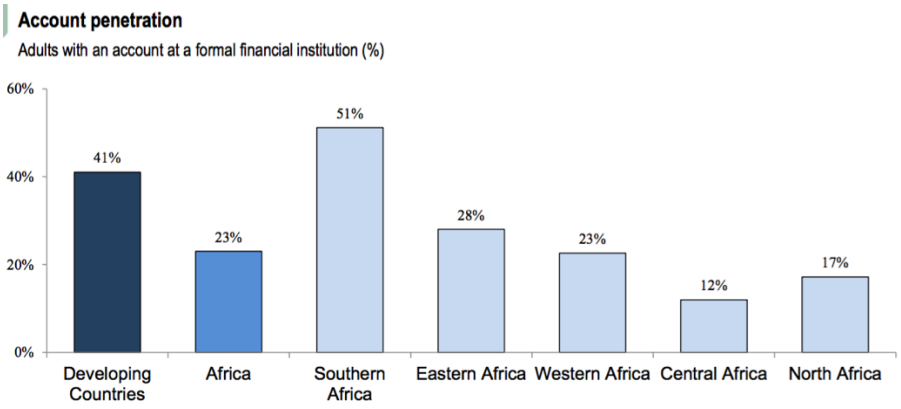


While formal lending is well-represented in wealthy economies, informal lending plays a large role in Africa.

3.4 A Closer Look at Africa:

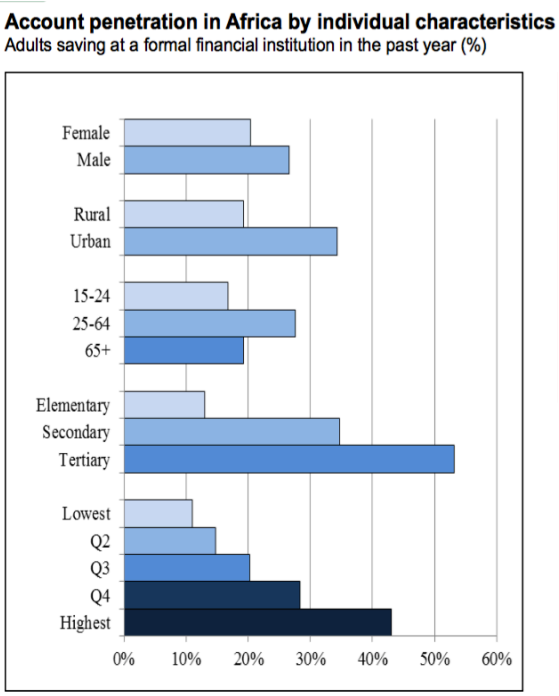
500 million adults in Africa remain excluded from the formal financial sector (Demirguc-Kunt, Klapper, 2012). Account penetration changes across regions as shown below:

Figure 3.3 Account Penetration Across Africa



Our project focuses on Kenya, and its sub-region, Eastern Africa, exhibits an account penetration of a mere 28 percent of adults.

Figure 3.4 Account Penetration by Characteristics



Source: Demirguc-Kunt, Klapper, 2012

Across regions, it appears that gender, age, location of services, and income levels create a discrepancy in access to institutions. I therefore will be controlling for these factors in my model specific for Kenya.

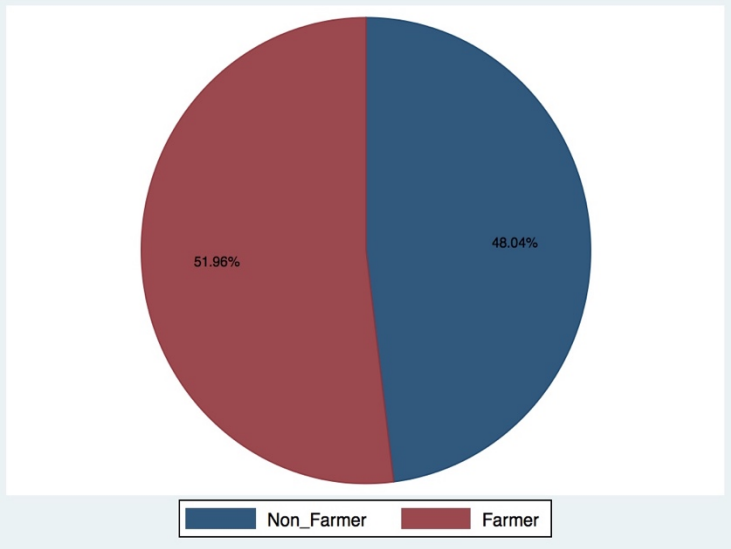
As for credit, only 5 percent of adults in Africa have reported borrowing from formal institutions, while 38 percent rely on lending from friends and families. Other forms of informal lending include employers and stores permitting sales on credit. Interestingly, wealth is not considered a determinant of the type of loan taken. The reasons for loans include funerals or weddings, school fees, and most abundantly for emergency purposes (Demirguc-Kunt, Klapper, 2012).

3.5 Analysis of the Sample:

The following analysis serves to paint a clear picture of the Kenya sample and its composition. My main purpose in this paper is to determine the factors affecting financial inclusion, and the latter's effect on vulnerability. Before we can introduce RCCs to Kenyan farmers, it is best to understand the economy's level of inclusion and riskiness. These attributes help determine the demand for the product, and its potential for success.

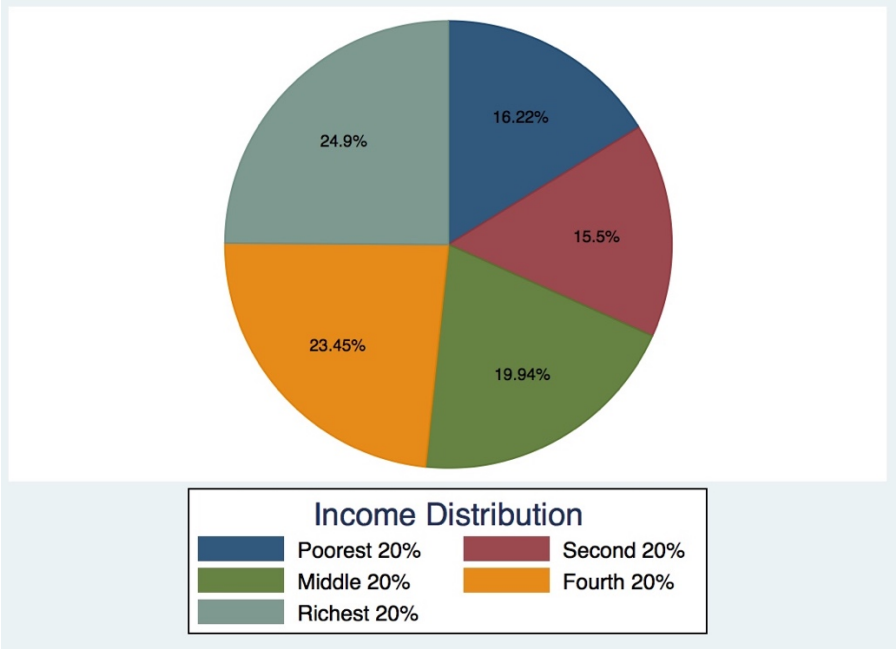
The sample consists of 968 observations, spread around Kenya, covering different economic and social classes. The sample is split almost equally between farmers and non-farmers, and between men and women. Farmers, the group the RCCs are targeted towards, represent 48.04 % of the sample. Meanwhile, women take up 51.55 % of the observations, and men 48.45%.

Figure 3.5 Farmers vs Non-Farmers Composition



The survey determines 5 different income quintiles, each taking up 20 percent of the national income. All quintiles are represented in this survey, yet there is a noticeable difference between the second quintile, with a mere 15.5 %, and the largest quintiles taking up around 48.35 % of the sample.

Figure 3.6 Distribution of Sample by Quintiles

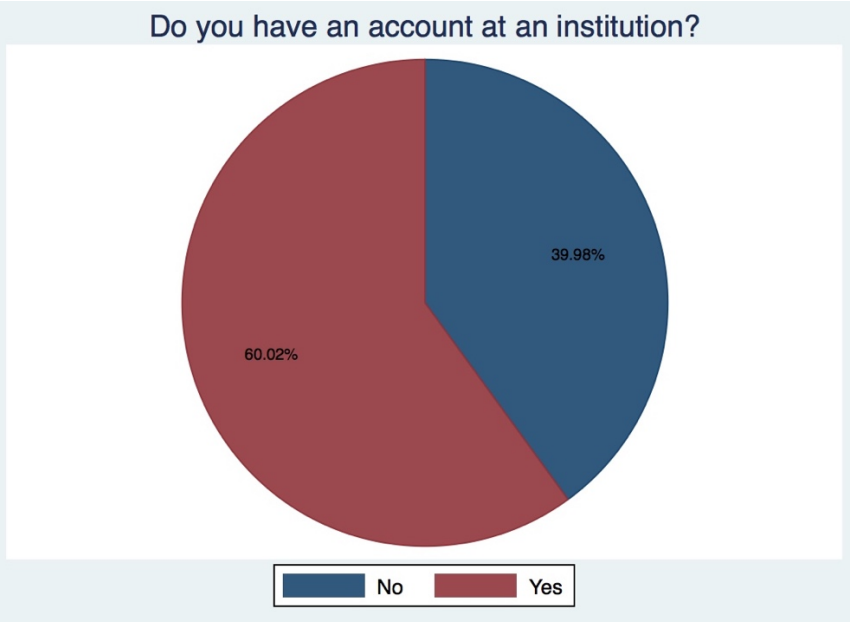


With regards to education, the majority of this sample has received secondary education, and only 6.618 % of this sample has gone beyond that.

3.5.1 Credit, Savings, and Vulnerability:

The core of this paper is identifying the factors that influence credit, savings, and vulnerability, and the simultaneous effect these three variables have on each other. Credit and savings are the main focus of this paper, yet institutional penetration – through accounts for deposits - clearly plays a big role with this form of inclusion.

Figure 3.7 Sample percentage with an Account

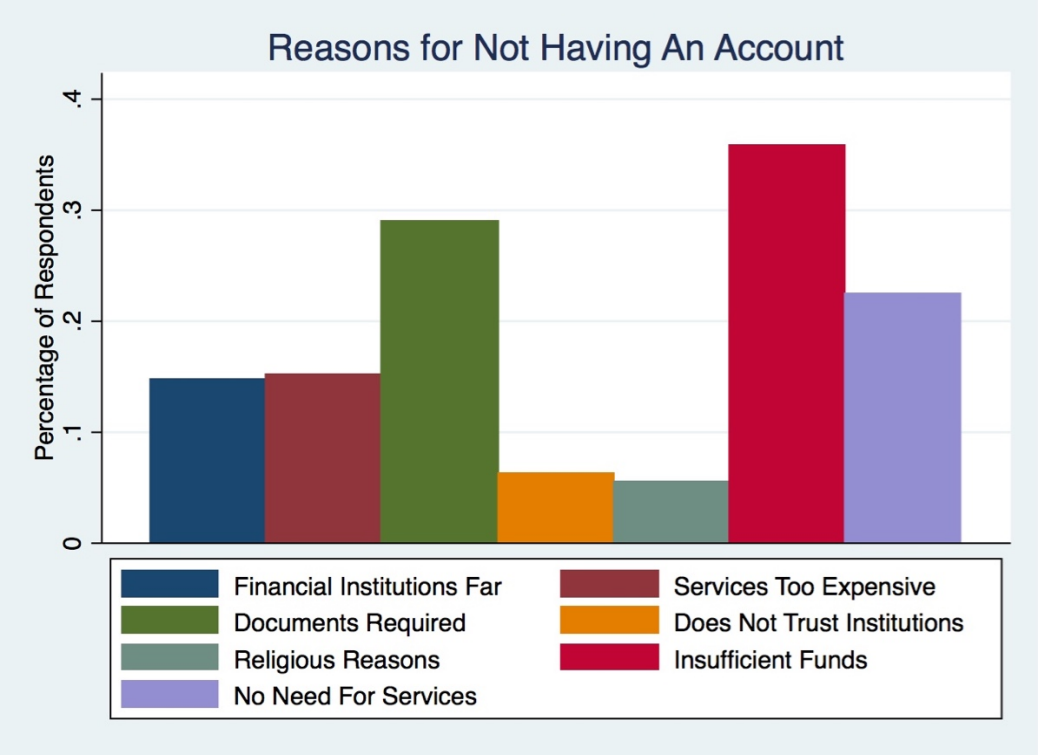


60.02 % of this sample, which includes both farmers and non-farmers from all income quintiles reported having an account.

When asked for the reasons some don't have an account, most reported it's due to a lack of funds and the number of documents required. In addition, some blamed the distance from the institutions, the cost of services, and, to a much smaller degree, their trust in institutions. Such

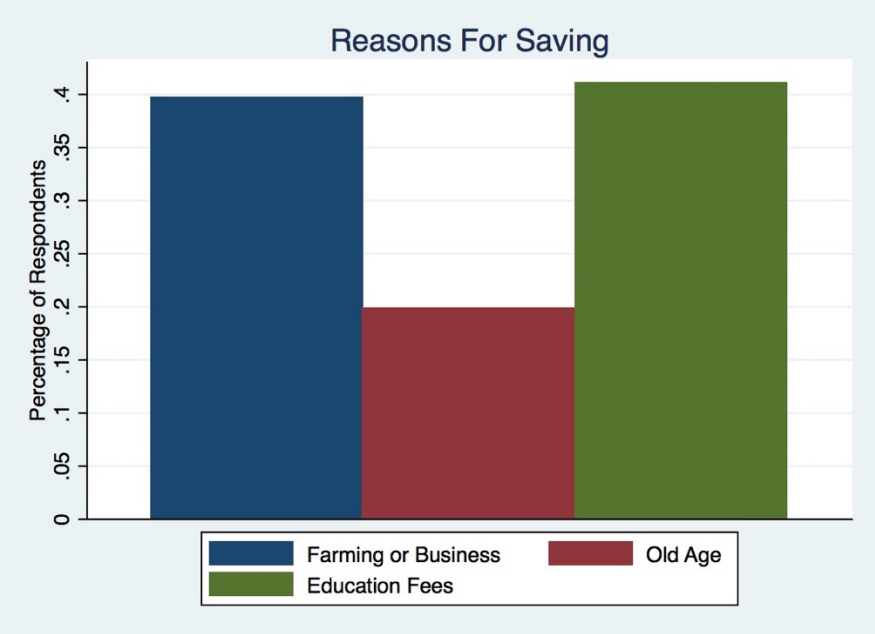
factors could also be large determinants of credit and savings, yet the survey never made that connection.

Figure 3.8 Reasons for Not Having an Account



In regards to savings, the most reported reason for savings was education fees, while saving for farming or business purposes trailed closely behind.

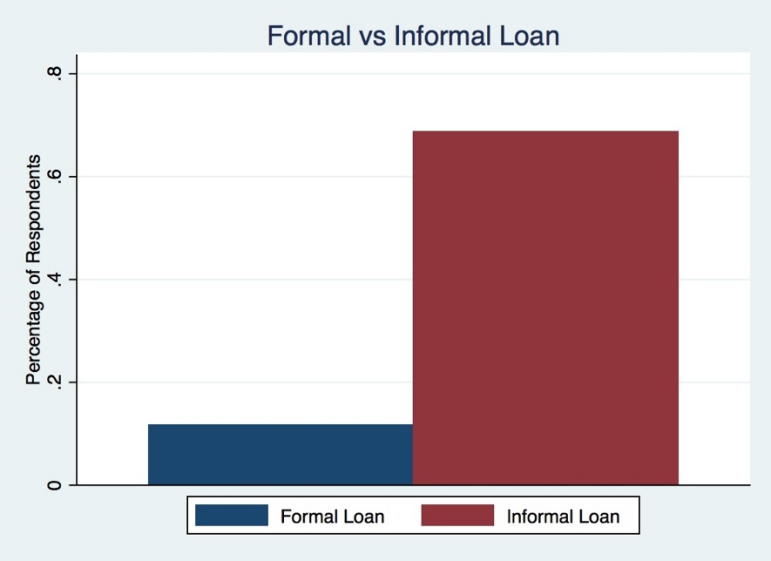
Figure 3.9 Reasons for Saving



3.5.2 Formal vs. Informal Loans:

With credit, there exists a large gap between loans taken from formal institutions and from informal methods.

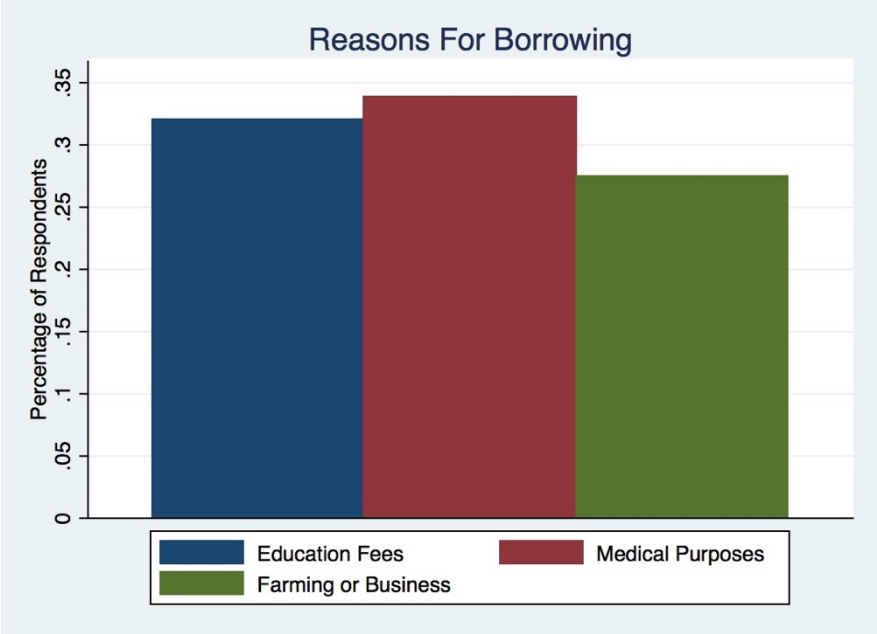
Figure 3.10 Formal vs. Informal Loans



Only 11.66 percent of all respondents took loans from formal institutions, while 68.5 percent relied on informal methods such as friends and relatives, employers, and business selling on credit.

The main reason for borrowing is reported to be medical purposes, followed by education fees and farming and business purposes.

Figure 3.11 Reasons for Borrowing



3.5.3 Farmers Vs Non-Farmers:

The following table presents the differences between farmers and non-farmers in usage of credit and other financial services:

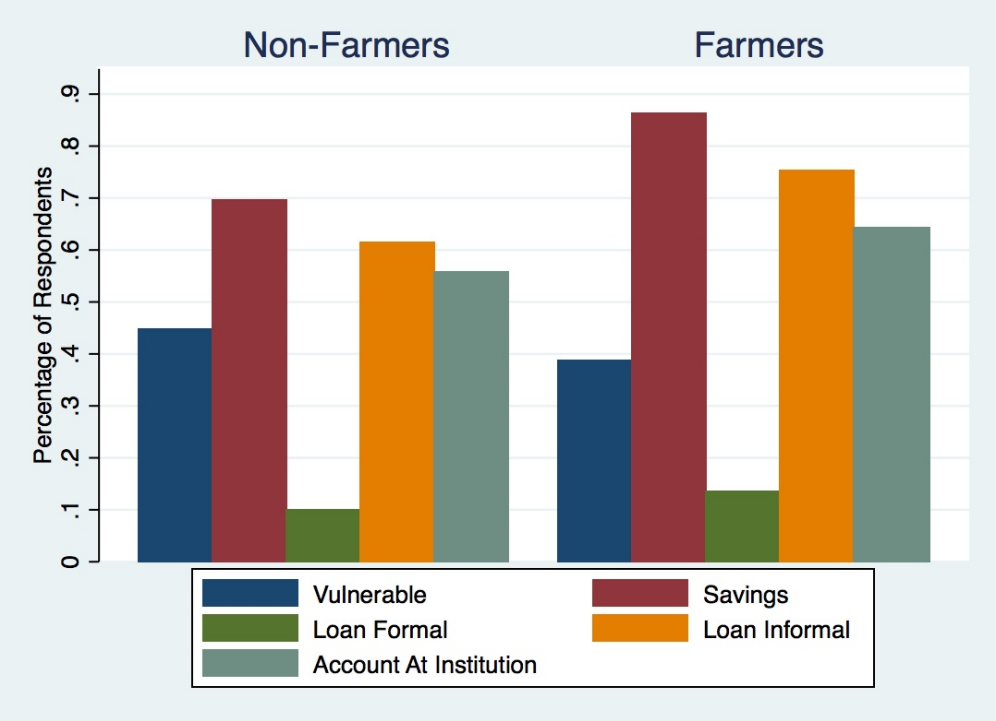
Table 3.1 Differences between Farmers and Non-Farmers

Variable	Percentage	Standard Deviation	T-Test for difference between means
Savings			
Non-Farmers	69.5 %	0.461	Significant with p-value of 0
Farmers	86.3 %	0.344	
Emergency Saving			
Non-Farmers	23.6 %	0.425	Insignificant with p-value of 0.757
Farmers	22.8 %	0.42	
Credit			
Non-Farmers	72.9 %	0.445	Significant with p-value of 0
Farmers	87.5 %	0.331	
Loan Formal			
Non-Farmers	9.67 %	0.295	Insignificant with p-value of 0.0647
Farmers	13.4 %	0.342	
Loan Informal			
Non-Farmers	61.3 %	0.487	Significant with p-value of 0
Farmers	75 %	0.433	
Vulnerable			
Non-Farmers	44.5 %	0.497	Insignificant with p-value of 0.572
Farmers	38.5 %	0.487	
Institution Account			
Non-Farmers	55.48 %	0.497	Significant with p-value of 0.006
Farmers	64 %	0.48	

Based on these statistics, significantly more farmers than non-farmers have had savings, yet both rely almost equally on savings for emergencies, although only 22-23 % of each of the two group do so.

More farmers rely on credit, since 87.5 % of them reported they've borrowed in some form, which is significantly larger than the 72.9 % of non-farmers. However, as expected, a very small percentage of each of these groups took loans from institutions. Only 9 percent of non-farmers and 13 percent of farmers took formal loans, and that difference is insignificant, meaning both approach institutional loans similarly.

Figure 3.12 Differences between Farmers and Non-farmers



The percentage of farmers and non-farmers taking out informal loans rises significantly, with 75 percentage of farmers borrowing through informal means. With vulnerability, only 38-44 percent of these group consider themselves vulnerable.

To minimize their vulnerability, the majority of both groups would opt for informal loans first – that is if these means are available.

Figure 3.13 Emergency Funds for Non-Farmers

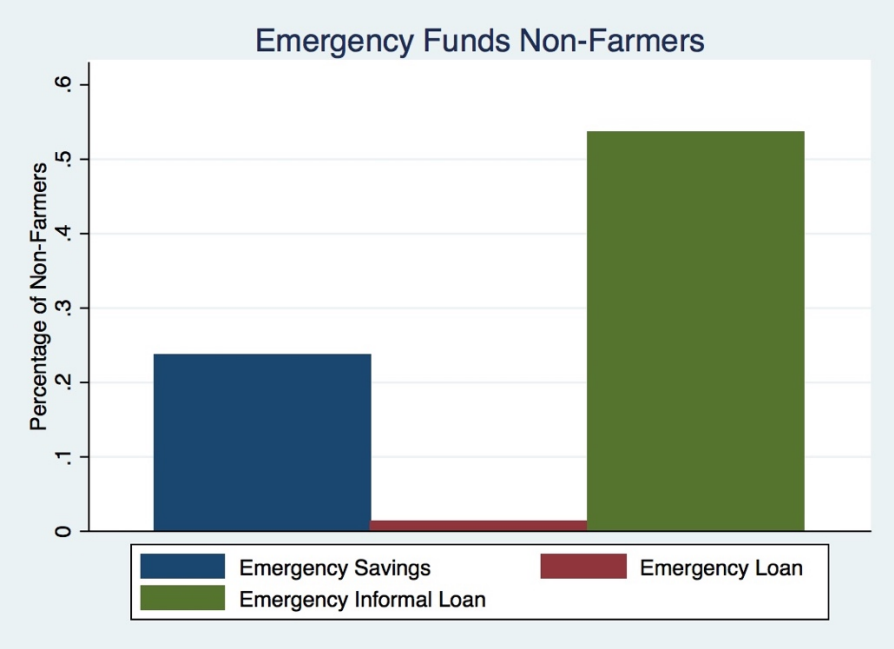
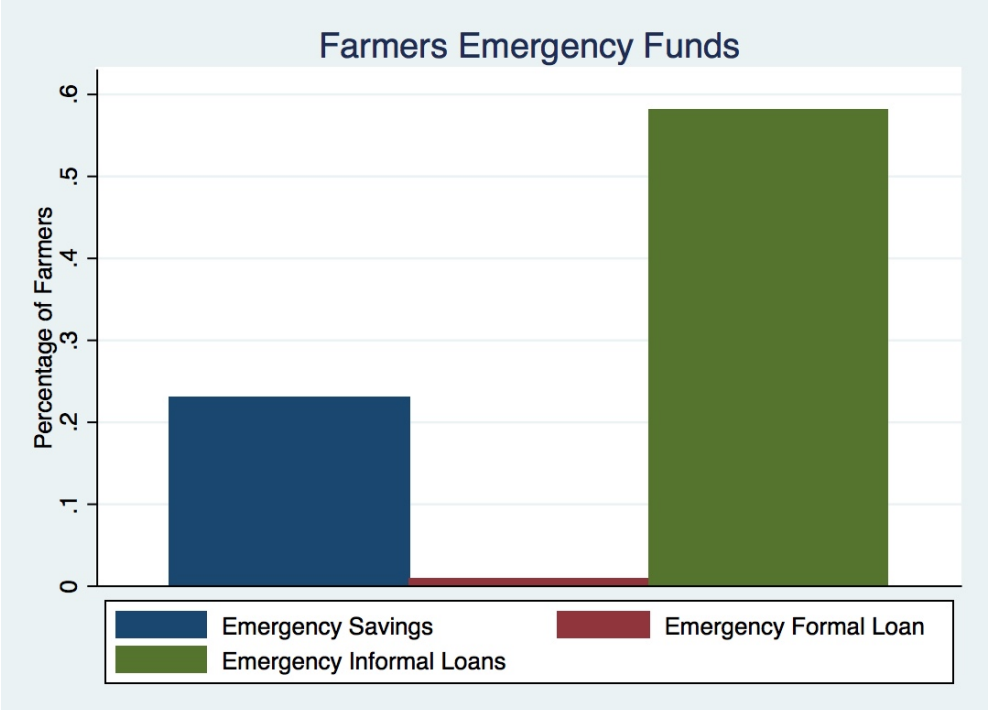


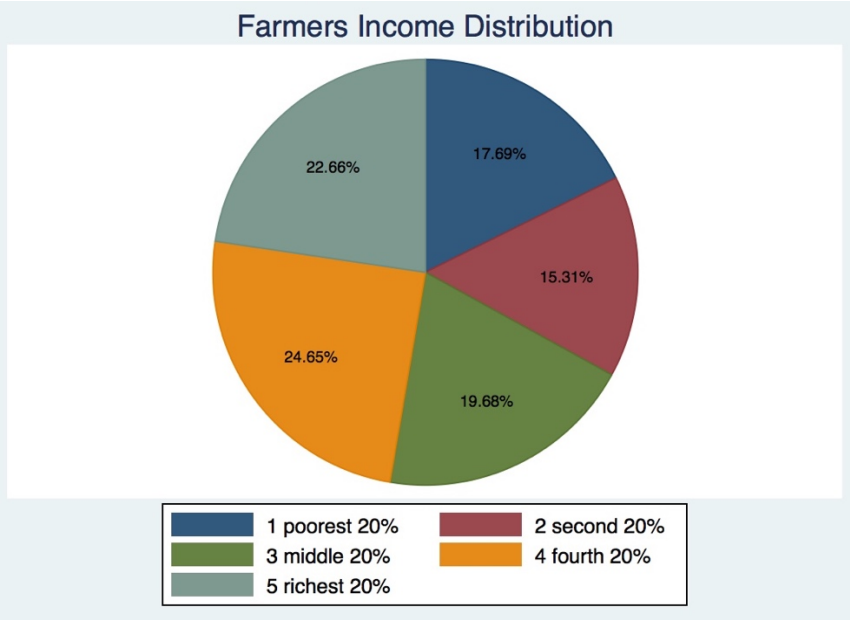
Figure 3.14 Emergency Funds for Farmers



3.5.4 Income Quintiles:

The distribution of farmers across quintiles strongly resembles that of the whole population:

Figure 3.15 Distribution of Farmers by Quintiles



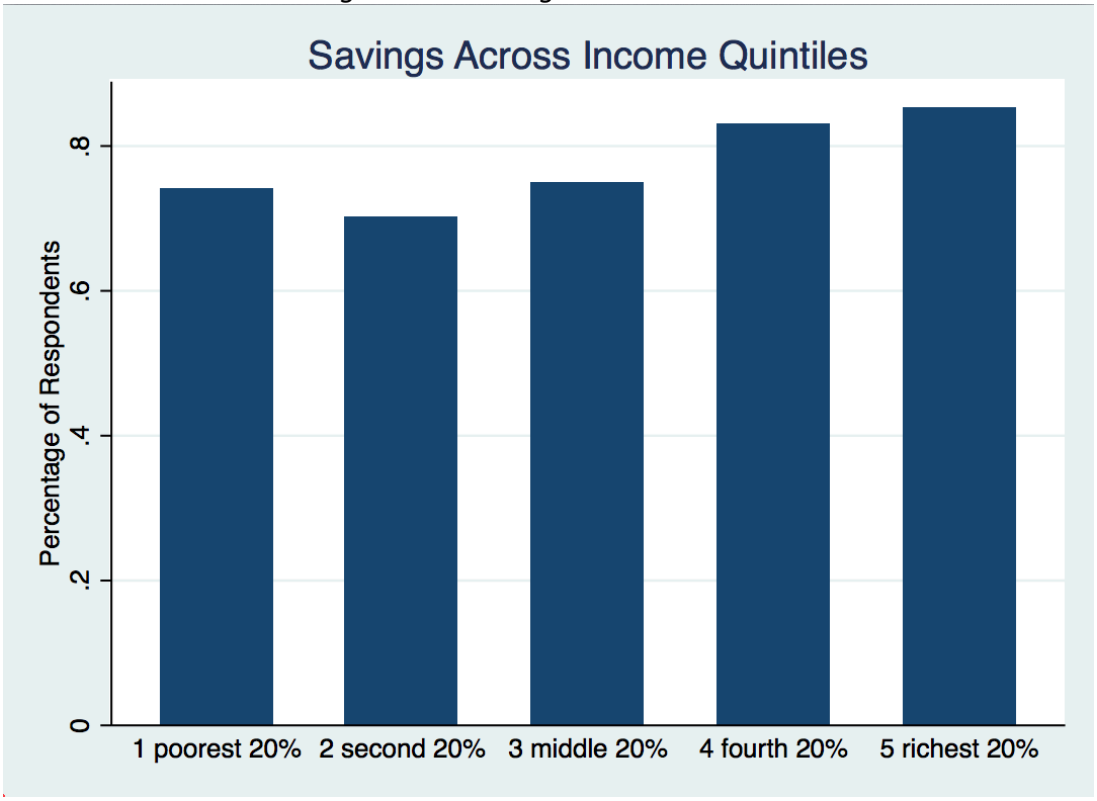
The following tables and graphs show the sample's usage of services across quintiles:

Table 3.2: Differences between Quintiles

	Poorest Quintile	Richest Quintile	Testing Significance of Difference
Saving	73.88 %	85.06 %	Significant with p-value of 0.005
Loan Formal	5.73 %	15.76 %	Significant with p-value of 0.002
Loan Informal	65.6 %	70.95 %	Insignificant with p-value of 0.87
Vulnerable	54.77 %	21.57 %	Significant with p-value of 0

Despite a drop in the second quintile, it appears that as income rises, more members of that income group begin to save. Additionally, 85.06% of people from the richest quintile saved, which is significantly larger than the poorest quintiles 73.88 %.

Figure 3.16 Savings Across Quintiles



As for formal loans, the percentage of people taking out formal loans rises with the income groups significantly, although it remains low with only 15.76 % at the richest quintile. With informal loans, it appears that people take out these loans regardless of income groups, with the bars reaching almost the same heights, and the difference between the poorest and richest groups remaining insignificant.

Figure 3.17 Formal Loans Across Quintiles

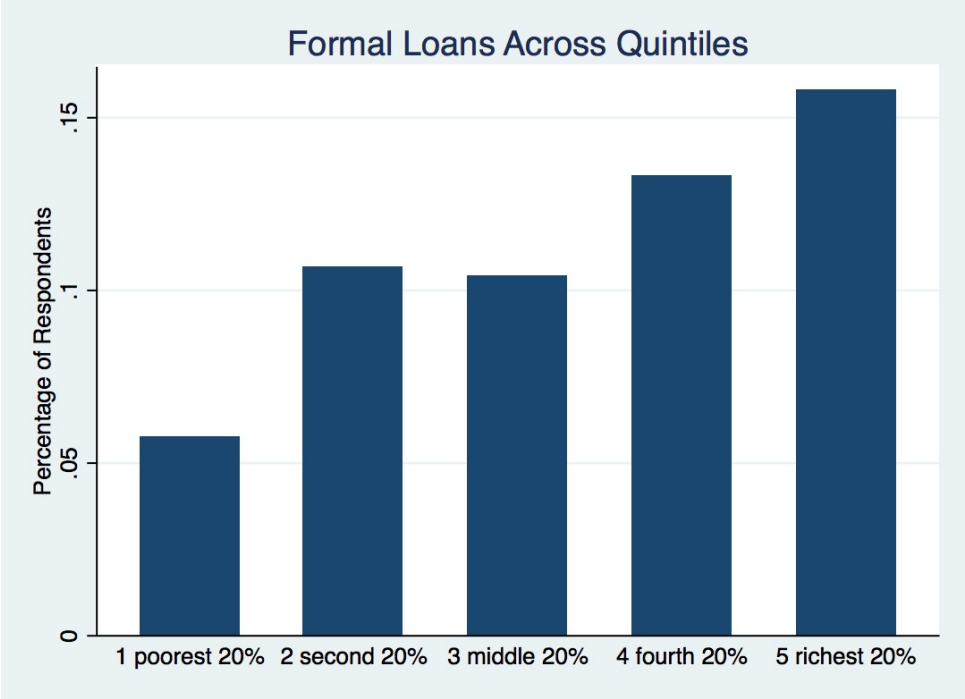
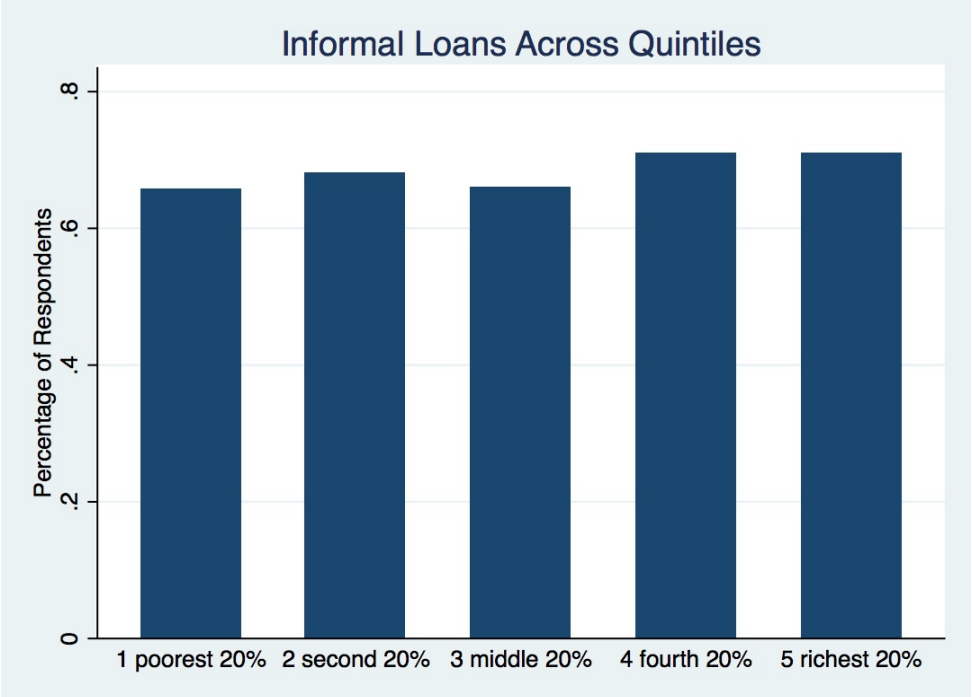
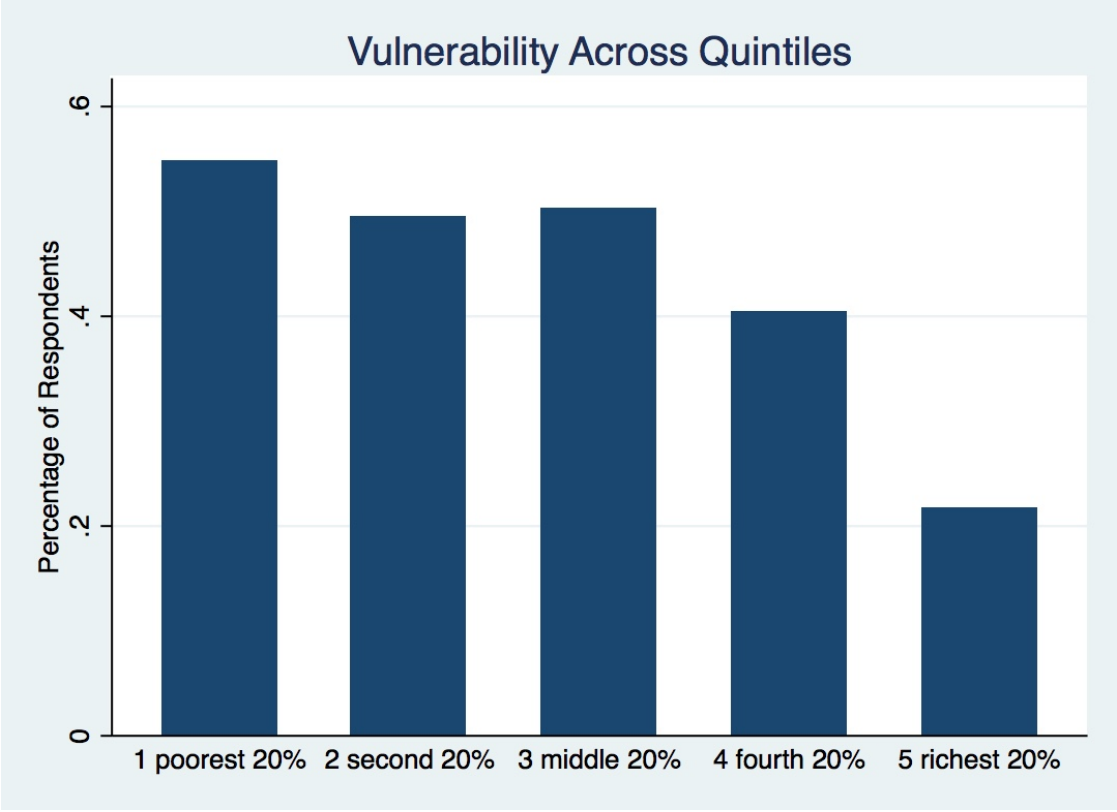


Figure 3.18 Informal Loans Across Quintiles



Finally, it appears more people in higher income groups perceive themselves as safe from shocks thanks to the availability of funds. The gap between the percentage of people in the richest group and the poorest group is quite significant.

Figure 3.19 Vulnerability Across Quintiles



CHAPTER IV

METHODOLOGY

4.1 Introduction

As mentioned earlier, access to financial services and usage of services are separate concepts. In this paper, I wish to determine the effects different factors have on Kenyans' *usage* of two main services, credit and savings, and their resulting effect on vulnerability. This helps us understand the connection between these services and vulnerability at an individual level, which has scarce literature backing it. Only through a proper understanding of the roles credit and vulnerability play with each other can we tackle farmers' vulnerabilities through RCCs.

4.2 Simultaneous-Equation Estimation:

My model consists of an analysis of the correlation of simultaneous variables in a three stage least square estimation model. Credit, savings, and vulnerability are simultaneously determined by an interrelated series of equations, rendering them individually endogenous and therefore inconsistent.

Simultaneity bias between financial intermediaries and savings has been controlled for in many of the literature, normally through instrumental variables as the data was either panel data or cross-country. Additionally, savings and credit show a significant correlation in the following correlation matrix, as does the vulnerability variable and the savings variable:

Table 4.1 Correlation Matrix

	Savings	Credit	Vulnerable
Savings	1		
Credit	0.329*	1	
	(0)		
Vulnerable	-0.196*	-0.043	1
	(0)	(0.181)	

P-values in parentheses

As for the relationship between credit and vulnerability, the literature is extensive. A market with full credit services can allow for consumption smoothing to easily occur in case of a shock, therefore reducing risk or vulnerability. Meanwhile, vulnerability is a determinant of whether demand for credit exists – regardless of actual usage.

The three-stage simultaneous equation system is set up the following way:

$$Savings = \alpha + \beta\, Credit + \beta 2\, Vulnerability + \beta 4\, Z1 + \beta 5\, Z2 + \varepsilon \quad (4.1)$$

$$Credit = \gamma 0 + \gamma\, Savings + \gamma 2\ Vulnerability + \gamma 3\, Z1 + \gamma 4\, Z3 + \epsilon \quad (4.2)$$

$$Vulnerability = \delta 0 + \delta\, Credit + \delta 2\, Savings + \delta 3\, Z1 + \varepsilon \quad (4.3)$$

Savings, Credit, and Vulnerability are the endogenous variables, and they appear individually on the left-hand side of one of the equations. They are binary dummy variables that take the value of 0 or 1, signifying whether respondents have saved money over the past year, have borrowed money from any source over the past year, and whether they consider themselves vulnerable to shocks, respectively. *Vulnerability* is contingent upon every respondent's access to emergency

funds, whether its savings or loans. Z represents the exogenous independent variables along with the error term ε.

In order to solve for one of the left hand side variables, such as *Savings*, all three equations must be accounted for simultaneously. Otherwise, estimates would be inconsistent since *Credit* and *Vulnerability* would be correlated with the movements of the error term.

To illustrate, *Savings* is a determinant of *Credit* although perhaps not blatantly or directly. However, *Vulnerability* is a determinant of those two dependent variables, but it is also a function of both. The survey specifically connects vulnerability with respondents' access to savings or credit funds in case of shocks. As a result, simultaneity becomes necessary in finding a solution for all equations.

4.2.1 The Exclusion Restriction:

As with most structural models, I needed to account for the identification of parameters in the equations. In the case of this 3SLS, the order condition requires that the number of excluded predetermined variables in every equation be greater than or equal to the total number of endogenous variables in the system of equations minus 1 – which in this case adds up to two. The excluded variables are therefore taken out of the set of variables denoted as Z in the above equations.

Although this simultaneous 3SLS model differs from the traditional IV 2SLS model, the intuition behind the exclusion restriction follows the same logic. Without the exclusion, the endogenous variables would be perfectly collinear with Z1 and Z2, and the model would collapse. The restriction creates "pseudo-IVs" from its excluded variables. Later in the paper, I rely on a traditional IV system of equations for robustness checks.

Insufficient funds and cost of services function as IVs specific to credit as they influence credit directly but not vulnerability. Cost of services is akin to the price of a product which is the main determinant of demand. Meanwhile the lack of sufficient funds could positively impact the need for credit in the short run. As for savings, the distance from institutions and the amount of trust in an institution can determine if an individual decides to save his/her money at that institution. Therefore, vulnerability does not include the institutional variables, since they impact it through the other endogenous variables, savings and credit.

4.2.2 Zellner Estimation:

The 3SLS Simultaneous-Equation model generates more efficient and consistent estimates than a series of independent single-equations as a result of the Zellner method. Single-equations from the same set of observations will display error terms that are correlated, yielding inefficient parameters.

Through this model, generalized least squares estimates are obtained. 3SLS begins by producing fitted values for the endogenous variables generated by a 2SLS model, and then it improves upon them in the third stage by taking into account any cross-equation correlation.

4.3 The Variables:

The predetermined exogenous variables in this model can be split into two groups, Z1 and Z2. Z1 is the set of characteristics of the individuals taking part in the survey. It includes gender, since this paper mentions earlier that a gender gap exists in developing countries. It also factors in income, since the top income quintile in developing economies has double the ease in financial penetration (Demirguc-Kunt, Klapper, 2012). This does not necessitate usage, and it will be

interesting in determining the difference. Additionally, the sample statistics show that more individuals save and take out loans from formal institutions if they belong to a higher income quintile.

In Africa, individuals in the age group between 25 and 64 exhibit the largest account penetration, as do individuals with higher education (Demirguc-Kunt, Klapper, 2012). These determinants of account penetration will be accounted for in my model for financial usage, and it will be wise to note whether their effect on usage is symmetric.

Z2 involves variables related to the individuals' perception of the state of institutions. Having a financial account is factored in yet its impact on demand for formal credit is dubious. On an institutional level, the distance from financial institutions and the cost of services are also included in the model. These variables are self-reported, and that controls for differences across individuals which would have been overlooked otherwise had a more systematic variable been used.

Savings and *Credit* share a simultaneous impact, yet the impact's sign could go in either direction. An increased level of savings or funds could reduce the risk of defaulting on loans and improve demand for credit. At the same time, more savings could simply mean less need for loans. A study has shown that both savings and loans in Kenya are mostly used for non-farming or business purposes. (Beck et al. 2007b) Thus, the availability of one could replace the other.

Finally, vulnerability plays a key role with both savings and credit. Most poor households use loans in order to smooth consumption. (Beck, World Bank, 2008) Additionally, another study in Kenya finds that households rely on savings to reduce the harmful impact of illnesses or other emergencies. (Beck et al. 2008)

Since the project with the RCCs is built on the principle of reducing vulnerability through a new form of credit, it is critical to determine traditional credit's effect on vulnerability and vice

versa. This could help forecast the impact this project has. Additionally, determining the factors influencing people's usage of financial services could help forecast the demand for this product, and could help us figure out who to tailor RCCs to.

4.4 Analysis

The 3SLS model is run using three different credit variables: the first variable factors in all types of credit – be it formal or informal, the second model only uses loans from formal institutions as a variable for credit, and the third variable refers to loans from informal institutions.

Table 4.2: The 3SLS Model for All Credit, Savings, and Vulnerability

	(1) Credit	(2) Formal Loan	(3) Informal Loan
Savings*	0.246	-0.112	0.379
	(0.41)	(-0.19)	(0.46)
Vulnerable*	2.561	0.992	2.596
	(0.91)	(0.35)	(0.70)
Bills	0.367	0.168	0.326
	(0.91)	(0.42)	(0.60)
Insufficient Funds	-0.141	-0.138	-0.139
	(-0.57)	(-0.55)	(-0.44)
Expensive Services	-0.195	-0.107	-0.204
	(-0.69)	(-0.37)	(-0.55)
Institutions Far	0.105	0.0378	0.124
	(0.76)	(0.27)	(0.69)
Trust In Institutions	-0.152	-0.0733	-0.137
	(-0.49)	(-0.23)	(-0.34)
Documents	0.0144	-0.00825	0.0164
	(0.19)	(-0.10)	(0.17)
Farmer	0.229	0.0756	0.216
	(1.00)	(0.33)	(0.70)
Financial Account	0.402	0.260	0.352
	(0.81)	(0.52)	(0.53)
Female	-0.0852	-0.0368	-0.0846
	(-0.75)	(-0.33)	(-0.55)
Education	0.103	0.0411	0.117
	(0.74)	(0.30)	(0.63)
Age	0.0000970	0.00385*	-0.00219
	(0.05)	(2.34)	(-0.77)
Income Quintiles	0.0901	0.0316	0.0866
	(1.07)	(0.38)	(0.77)
_cons	-1.171	-0.613	-1.314
	(-0.88)	(-0.46)	(-0.74)

Table 4.2 (Continued)

	Savings	Savings	Savings
Vulnerable*	-0.537***	0.407	-0.684***
	(-5.73)	(0.79)	(-5.66)
Credit*	0.752***		
	(3.95)		
Bills	-0.00332	0.126**	-0.00347
	(-0.21)	(2.68)	(-0.24)
Farmer	0.000138	0.133**	-0.0153
	(0.00)	(3.12)	(-0.34)
Institutions Far	0.00000959	0.0345	-0.00115
	(0.00)	(0.74)	(-0.14)
Income Quintile	-0.0334**	-0.00128	-0.0329*
	(-2.80)	(-0.06)	(-2.25)
Trust In Institutions	-0.00630	0.0565	-0.00572
	(-0.30)	(0.60)	(-0.29)
Documents	-0.00407	0.0667	-0.00372
	(-0.27)	(1.25)	(-0.28)
Account	0.149**	0.232***	0.125*
	(3.10)	(3.36)	(2.07)
Education	0.00338	0.0504	-0.0166
	(0.13)	(1.23)	(-0.51)
Female	0.00302	-0.0246	0.00927
	(0.11)	(-0.65)	(0.29)
Age	-0.000439	-0.00529	0.00151
	(-0.40)	(-1.25)	(1.04)
Formal Loan*		1.320	
		(1.36)	
Informal Loan*			0.799***
			(3.62)
_cons	0.403**	0.189	0.516**
	(2.68)	(0.80)	(3.21)

Table 4.2 (Continued)

	Vulnerable	Vulnerable	Vulnerable
Credit*	1.314***		
	(3.45)		
Savings*	-1.838***	-0.372	-1.470***
	(-5.38)	(-0.65)	(-5.53)
Government Support	0.00862	0.0989	0.00556
	(0.33)	(1.40)	(0.28)
Farmer	0.00728	-0.00798	-0.0165
	(0.11)	(-0.11)	(-0.25)
Income Quintile	-0.0612**	-0.0327	-0.0481**
	(-3.29)	(-1.74)	(-2.74)
Insufficient Funds	0.00983	0.0962	0.00550
	(0.33)	(0.89)	(0.29)
Account	0.287*	0.155	0.194
	(2.44)	(1.11)	(1.64)
Education	0.00598	-0.0336	-0.0230
	(0.13)	(-0.72)	(-0.51)
Female	0.00540	0.0161	0.0130
	(0.12)	(0.36)	(0.29)
Age	-0.000766	0.00367	0.00212
	(-0.40)	(0.73)	(1.06)
Formal Loan*		-0.994	
		(-0.89)	
Informal Loan*			1.125***
			(3.66)
_cons	0.767***	0.695*	0.766***
	(3.73)	(2.13)	(3.82)
N	968	968	968

t statistics in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

With the pooled credit variable, no independent variable stands out as a significant link with the dependent variable. *Savings* appears to be positively correlated with *Credit*, albeit insignificantly, a result that appears to be generally reciprocated across equations. People who save more tend to take out more credit in all its forms. The variable that's closest to significance in the case of *Credit* is the income level with a p-value of 0.285. The income group people belong to does influence usage of credit positively. Additionally, vulnerability exhibited the largest estimate, implying that as vulnerability increases, credit usage increases by a lot.

The *Savings* equation tells a better story. If people perceived themselves as vulnerable, that reduced their savings significantly. These numbers are corroborated for when the different types of loans are accounted for. Meanwhile *Credit* and *Savings* again exhibit that they are positively linked, and credit's effect is quite significant. The direction flows from credit to savings, but not the other way around. Meanwhile, having an account encouraged savings, yet its impact on credit usage was insignificant. Finally, as income quintile rose, less savings occurred.

Credit and savings both significantly influenced vulnerability. The more people saved, the less vulnerable they considered themselves, while credit had the opposite effect, surprisingly. Loan usage pushed people to consider themselves as more vulnerable. Meanwhile, a person's wealth had the opposite effect. With saving's negative impact on vulnerability, my results fit the literature which states that savings are more targeted towards non-farming practices – in this case, emergencies. The results hold up across all three models.

Financial penetration, in this case referred to as "Account", does not tell a consistent story. It appears that having an account at an institution positively influences one's perception of their own vulnerability. It also has an insignificant impact on the usage of credit. Even in the case with formal

loans, it does not significantly impact people's reliance on loans from formal institutions. It appears that financial penetration does not imply usage of credit or therefore easier risk smoothing.

Having an account does not improve the demand for loans from those institutions. The hassle of the paperwork does not hinder those demand significantly either. It appears that financial penetration and the ease of access are not significant determinants of demand with our sample. Additionally, it is not people's perception of the services that influences their demand.

As for savings, formal loans also have a positive impact, as do informal loans. In fact, relying on informal loans appears to be the biggest driver of savings. Relative to formal loans, farmers tend to significantly save more.

Informal loans appear to increase people's belief that they are vulnerable, while taking out formal loans has no noticeable impact. Loans, from informal institutions, makes participants consider themselves more prone to shocks. The results are surprising as loans are an encouraged instrument for risk smoothing in the general literature.

In general, formal institutions play a significant role in this model only when it comes to savings. Access to those institutions and their characteristics did not encourage credit use. Their services, in this case credit use, did not encourage savings. These services and the level of penetration did not affect people's vulnerabilities.

The key players with people's vulnerability were savings, informal credit, and income level. RCCs target people's level of vulnerability, yet it is a form of formal credit. The literature does identify collateral requirements as a form hindrance towards credit, and that variable was not included in this survey. Therefore, formal credit (and RCCs) could still play a major role.

It is also worth noting that the gender gap does not play a significant role in people's usage of credit or savings. There is also no significant gap in vulnerability. Similarly, education does not

influence the endogenous variables in a crucial way. It does point towards improved usage of savings and credit, and a decrease in vulnerability, yet never significantly.

In this next section of the analysis, I divide the sample into farmers and non-farmers, and I run the same model as earlier in order to compare the estimates between samples.

Table 4.3 Farmers vs Non-Farmers 3SLS Model

	Non-Farmer Credit	Farmer Credit	Non-Farmer Loan Informal	Farmer Loan Informal	Non-Farmer Loan Formal	Farmer Loan Formal
Savings*	0.491	0.549	0.471	0.419	0.0643	0.374
	(0.84)	(0.64)	(1.34)	(0.05)	(0.09)	(0.07)
Vulnerable*	2.872	1.193	1.899	1.965	2.384	-0.514
	(0.91)	(0.32)	(1.10)	(0.05)	(0.61)	(-0.02)
Bills	0.526	0.0889	0.342	0.0127	0.405	-0.0270
	(0.89)	(0.25)	(1.04)	(0.00)	(0.55)	(-0.01)
Insufficient Funds	-0.0764	-0.0590	0.0346	-0.0473	-0.184	-0.0420
	(-0.34)	(-0.14)	(0.28)	(-0.01)	(-0.66)	(-0.02)
Expensive Services	-0.178	-0.0628	-0.0768	0.0766	-0.147	-0.108
	(-0.47)	(-0.22)	(-0.37)	(0.03)	(-0.32)	(-0.06)
Institutions Far	-0.0433	0.0669	-0.0656	0.315	0.0359	0.0834
	(-0.38)	(0.16)	(-0.88)	(0.08)	(0.27)	(0.03)
Trust Institutions	-0.147	-0.00430	-0.0726	0.458	-0.0354	-0.551
	(-0.38)	(-0.01)	(-0.34)	(0.11)	(-0.07)	(-0.20)
Documents	0.164	-0.0624	0.132	0.212	0.0724	-0.0978
	(1.30)	(-0.29)	(1.75)	(0.10)	(0.55)	(-0.07)
Account	0.275	0.191	0.244	0.545	0.289	-0.0188
	(0.76)	(0.20)	(1.19)	(0.06)	(0.63)	(-0.00)
Female	-0.167	-0.0106	-0.124	0.00585	-0.151	0.0240
	(-0.74)	(-0.22)	(-0.99)	(0.02)	(-0.55)	(0.09)
Education	0.0588	0.0510	0.0369	0.130	0.0367	-0.0131
	(0.54)	(0.21)	(0.58)	(0.05)	(0.29)	(-0.01)
Age	0.00339	-0.0008	-0.000163	-0.00223	0.00568	0.00385
	(0.71)	(-0.24)	(-0.06)	(-0.07)	(1.02)	(0.18)
Income Quintile	0.191	0.0209	0.137	0.0204	0.143	0.00306
	(1.00)	(0.86)	(1.30)	(0.10)	(0.61)	(0.02)
_cons	-1.818	-0.303	-1.218	-1.426	-1.840	0.456
	(-0.97)	(-0.24)	(-1.19)	(-0.12)	(-0.80)	(0.06)

Table 4.3 (Continued)

Savings	Non-Farmer	Farmer	Non-Farmer	Farmer	Non-Farmer	Farmer
Vulnerable*	-0.749***	-0.588***	-0.844***	-0.580	-0.224	-1.958
	(-3.34)	(-7.35)	(-3.71)	(-1.63)	(-0.63)	(-1.21)
Credit*	0.499*	1.091**				
	(2.45)	(2.71)				
Bills	0.0344	-0.0121	0.0265	0.0171	0.189**	0.00590
	(0.66)	(-0.72)	(0.51)	(0.36)	(2.75)	(0.20)
Institutions Far	-0.000415	0.0079	0.00150	-0.00172	-0.0425	-0.0496
	(-0.01)	(0.52)	(0.04)	(-0.10)	(-0.60)	(-0.25)
Income Quintile	-0.0669**	-0.0207	-0.0755**	-0.00653	-0.0299	-0.00251
	(-2.94)	(-1.32)	(-3.15)	(-0.39)	(-1.05)	(-0.07)
Trust Institutions	-0.00325	-0.0762	0.00329	-0.0118	-0.0222	0.0968
	(-0.07)	(-0.85)	(0.08)	(-0.27)	(-0.26)	(0.26)
Documents	0.0105	0.0126	0.0127	-0.0212	0.114	0.0396
	(0.25)	(0.65)	(0.32)	(-0.35)	(1.92)	(0.25)
Account	0.178**	0.0682	0.165**	0.147	0.242***	0.476*
	(3.05)	(0.69)	(2.59)	(0.97)	(3.88)	(2.25)
Education	0.00299	-0.00230	0.000428	-0.0274	0.0307	-0.0266
	(0.08)	(-0.06)	(0.01)	(-0.48)	(0.76)	(-0.28)
Female	0.000564	0.0074	0.0122	0.0101	-0.0313	0.102
	(0.01)	(0.18)	(0.27)	(0.24)	(-0.70)	(0.82)
Age	-0.00215	0.0003	-0.000904	0.00168	-0.00355	0.0160
	(-1.23)	(0.21)	(-0.46)	(0.75)	(-1.60)	(0.86)
Loan Informal*			0.526*	0.621		
			(2.35)	(1.09)		
Loan Formal*					0.590	-3.083
					(1.31)	(-0.90)
_cons	0.804***	0.204	0.884***	0.501*	0.666*	0.987**
	(3.36)	(0.74)	(3.68)	(2.04)	(2.38)	(3.24)

Table 4.3 (Continued)

Vulnerable	Non-Farmer	Farmer	Non-Farmer	Farmer	Non-Farmer	Farmer
Credit*	0.586*	1.199				
	(2.18)	(1.65)				
Savings*	-1.104***	-1.752***	-1.053***	-1.433***	-0.492	-0.635*
	(-4.24)	(-6.86)	(-4.30)	(-4.92)	(-1.70)	(-2.03)
Government Support	0.00262	0.0326	-0.0000980	-0.0212	0.157	0.0220
	(0.05)	(0.82)	(-0.00)	(-0.26)	(1.06)	(0.24)
Income Quintile	-0.0846***	-0.0282	-0.0869***	-0.00822	-0.0695***	-0.00294
	(-4.17)	(-1.06)	(-4.18)	(-0.38)	(-3.55)	(-0.13)
Insufficient Funds	0.0207	0.0742	0.00976	0.0206	0.0598	0.0188
	(0.48)	(0.86)	(0.23)	(0.62)	(0.69)	(0.25)
Account	0.184*	0.272	0.160	0.167	0.134	0.276*
	(2.02)	(1.15)	(1.76)	(0.95)	(1.52)	(2.13)
Education	-0.00248	-0.0062	-0.00370	-0.0544	-0.0221	-0.0149
	(-0.05)	(-0.10)	(-0.08)	(-0.97)	(-0.46)	(-0.25)
Female	0.0111	0.0172	0.0207	0.0150	0.0101	0.0485
	(0.22)	(0.27)	(0.41)	(0.27)	(0.20)	(0.84)
Age	-0.00254	0.0008	-0.000963	0.00303	0.000146	0.00693
	(-1.18)	(0.30)	(-0.43)	(1.30)	(0.03)	(1.92)
Loan Informal*			0.597*	1.086**		
			(2.16)	(2.70)		
Loan Formal*					-0.612	-1.338*
					(-0.58)	(-2.25)
_cons	1.000***	0.644	1.005***	0.659	0.974***	0.639*
	(6.37)	(1.28)	(6.35)	(1.87)	(4.90)	(2.39)
N	465	503	465	503	465	503

t statistics in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Since the RCC project seeks to target farmers, it is best to compare the estimates generated by a sample of farmers only and non-farmers only. Non-farmers are individuals who receive wages through non-farming employment.

Both farmers and non-farmers do not indicate any strong variable encouraging demand for credit. Saving displays a positive relationship with any form of credit, as does vulnerability, yet their effect is insignificant. It remains unclear what drives or hinders the demand of any form of credit across samples. Perception of credit seems to be homogenous regardless of whether one's a farmer or not.

If a non-farmer considers himself more vulnerable to shocks, they are less able or likely to save. This effect is more pronounced with non-farmers than farmers. On the other hand, credit appears to positively influence savings, yet the effect is isolated to loans from informal sources.

Income quintiles is significant player with non-farmers. It discourages savings while improving people's confidence in facing shocks. It does not share this effect with farmers, where it appears that income level is not a helpful tool in determining one's usage of savings or level of vulnerability.

In the earlier section, I identified that financial penetration only influenced savings in our sample. This positive effect is isolated to non-farmers only; another non-farmer exclusive trait in addition to income quintiles.

Savings is accompanied with a reduction in vulnerability with both farmers and non-farmers. Meanwhile, as pointed out earlier, credit appears to be correlated with a higher level of vulnerability. That is isolated to informal loans with both samples. Farmers and non-farmers who have taken out informal loans tend to report a higher level of vulnerability. However, farmers identified a reduced level of vulnerability when taking out loans from financial institutions. This

is a sign of hope for the project seeks to accomplish just that. Meanwhile, institutional and individual characteristics continue to play an insignificant role in this model

In general, the positive influence financial penetration had on savings with the entire sample is limited to non-farmers. Additionally, the negative relationship between income quintile and savings, and income level and vulnerability observed with the entire sample is also limited to non-farmers. The positive relationship between credit and savings, and credit and vulnerability, exists with both samples of farmers and non-farmers, but is isolated to the informal sector. Formal loans and informal loans held opposite effects on vulnerability with farmers only.

4.5 Robustness Checks:

I conducted a robustness check using a three-stage IV-logit model, controlling for the endogeneity of Credit and Savings in the first two stages and fitting their predicted linear values into the final stage that has vulnerability, a binary variable, as the dependent variable. The results corroborated the increased level of vulnerability experienced by the usage of informal loans and lent further hope to formal loans acting as a method to smooth vulnerability.

The logit model aids in maintaining linearity between the binary dependent variable, vulnerability, and the categorical independent variables, such as income quintile which can take on a discrete value from 1 to 5. The logit estimates aid in predicting the odds of an event affecting the dependent variable, or the changes in probability.

The final stage of the logit model is:

$$Vulnerable = \alpha + \beta\ Savings + \beta\ Credit + \ \beta\ W + \ \varepsilon \quad (4.5.1)$$

where W represents the same predetermined variables as earlier.

The first two stages look as follows:

$$Savings = \alpha + \gamma Z1 + \gamma W + \varepsilon \quad (4.5.2)$$

$$Credit = \alpha + \delta Z2 + \gamma W + \varepsilon \quad (4.5.3)$$

The fitted values of savings and credit are then replaced in vulnerability's logit equation. Z1 represents the same instruments used in the earlier model with an instrument added specifically for savings, the use of a debit card. Similarly, Z2 includes the same instruments in the earlier model with another instrument included specifically for credit, the usage of a credit card. These instrument have been demonstrated to be valid as they influence their respective endogenous variables without having a direct link to vulnerability.

The following are separate one-stage single equation logits for the three variables:

Table 4.4: Single-Equation Logit Model for Credit as Dependent Variable

	(1) Credit	(2) Loan Formal	(3) Loan Informal
Savings*	1.494***	1.207*	1.116***
	(7.52)	(2.44)	(6.19)
Vulnerable*	0.196	0.118	0.130
	(1.03)	(0.48)	(0.82)
Account	0.810**	1.529*	0.394
	(2.92)	(2.53)	(1.63)
Institutions Far	-0.392	0.0625	-0.464
	(-1.37)	(0.08)	(-1.85)
Expensive Services	0.282	-0.528	0.469
	(0.96)	(-0.59)	(1.81)
Documents	0.386	-1.124	0.0919
	(1.40)	(-1.07)	(0.39)
Insufficient Funds	0.786**	-0.903	0.589*
	(2.90)	(-1.55)	(2.47)
Age	0.00266	0.0419***	-0.0119
	(0.35)	(4.68)	(-1.94)
Education	0.0109	0.00693	0.115
	(0.06)	(0.03)	(0.82)
Income Quintile	0.121	0.0209	0.0341
	(1.73)	(0.23)	(0.58)
Female	-0.0216	0.0396	-0.0345
	(-0.12)	(0.18)	(-0.23)
Farmer	0.772***	0.000439	0.571***
	(4.06)	(0.00)	(3.70)
_cons	-1.295*	-5.637***	-0.756
	(-2.49)	(-6.31)	(-1.71)
N	968	968	968

t statistics in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 4.5: Single-Equation Logit Model for Savings as Dependent Variable

	(1) Savings	(2) Savings	(3) Savings
Credit*	1.493***		
	(7.45)		
Vulnerable*	-0.599**	-0.561**	-0.573**
	(-3.21)	(-3.13)	(-3.13)
Account	1.295***	1.457***	1.427***
	(4.75)	(5.54)	(5.35)
Institutions Far	0.121	-0.00294	0.138
	(0.46)	(-0.01)	(0.53)
Trust Institutions	0.174	0.383	0.270
	(0.53)	(1.22)	(0.84)
Expensive Services	-0.122	0.0166	-0.133
	(-0.46)	(0.07)	(-0.51)
Documents	-0.0292	0.132	0.0729
	(-0.11)	(0.54)	(0.29)
Insufficient Funds	-0.00410	0.284	0.0665
	(-0.02)	(1.13)	(0.26)
age	-0.00161	-0.00374	0.000992
	(-0.22)	(-0.52)	(0.14)
Education	0.266	0.286	0.252
	(1.51)	(1.69)	(1.46)
Income Quintile	-0.0360	-0.0197	-0.0185
	(-0.50)	(-0.28)	(-0.26)
Female	-0.157	-0.149	-0.133
	(-0.87)	(-0.85)	(-0.75)
Farmer	0.780***	1.013***	0.829***
	(4.09)	(5.49)	(4.41)
Loan Formal*		1.284**	
		(2.66)	
Loan Informal*			1.084***

			(5.96)
_cons	-0.849	-0.397	-0.775
	(-1.41)	(-0.69)	(-1.30)
N	968	968	968

t statistics in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 4.6: Single-Equation Logit Model for Vulnerability as Dependent Variable

	(1) Vulnerable	(2) Vulnerable	(3) Vulnerable
Credit*	0.208		
	(1.08)		
Savings*	-0.580**	-0.527**	-0.556**
	(-3.13)	(-2.96)	(-3.06)
Government Support	0.245	0.254	0.246
	(1.03)	(1.06)	(1.03)
Female	0.0897	0.0884	0.0896
	(0.63)	(0.63)	(0.63)
Age	-0.00117	-0.00146	-0.000883
	(-0.20)	(-0.25)	(-0.15)
Education	-0.219	-0.218	-0.221
	(-1.61)	(-1.60)	(-1.63)
Income Quintile	-0.178**	-0.176**	-0.176**
	(-3.22)	(-3.18)	(-3.19)
Account	-0.594**	-0.576**	-0.579**
	(-2.75)	(-2.67)	(-2.69)
Insufficient Funds	0.461*	0.491*	0.471*
	(2.20)	(2.35)	(2.25)
Farmer	-0.198	-0.177	-0.193
	(-1.34)	(-1.20)	(-1.30)
Loan Formal*		0.0623	
		(0.26)	
Loan Informal*			0.135
			(0.85)
_cons	1.106**	1.191**	1.135**
	(2.74)	(2.99)	(2.83)
N	968	968	968

t statistics in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.00$

First round single-equation logits describe the odds connecting the variables. Although the estimates are biased and inconsistent, they do give some insight. Savings in this appears to improve the odds of taking out loans, whether it's formal or informal. According to these results, one-unit increase in savings predicts around 1.5 increase in the log of odds of taking out loans. I know from the earlier analysis that these variables are inconsistent, yet even in this case with the inflated estimates, savings' effect on formal loans continues to have minimal significance. This goes to show the weak drivers behind the demand for formal loans.

If age increases by one unit, the log likelihood of taking out formal loans rises by 0.04, a small yet significant number. This find matches the earlier 3SLS model. Additionally, if insufficient funds worsen, they improve the likelihood of taking out an informal loan.

If one becomes a farmer, that increases the log likelihood of taking out loans from informal sources by a significant 0.571. Farmers' attitudes towards loans remains ambiguous when factoring in all models. In addition, having a financial account increases the odds of taking formal loans by 1.53. The number isn't heavily significant, and it continues to prove that financial penetration encourages savings more than credit in Kenya. In fact, having an account increases the odds of saving by more than 1 at an unanimously significant level of $p<0$. Credit displays the same effect on savings, with the credit weighted more heavily towards informal loans than formal loans.

Vulnerability continues to display a negative relationship on savings. If one begins to consider himself vulnerable, the odds of them savings drops by more than half. On the other hand, if one identifies as a farmer, the odds of them saving increases by an estimate between 0.8 and 1. This matches an earlier result.

As for vulnerability, credit's effect is insignificant yet it is worth noting that it is positive. After correcting for endogeneity in the next section, informal credit's positive effect on the odds of considering oneself vulnerable becomes more clear.

If one saves, the odds they consider themselves vulnerable drops by half. Moving up income quintiles has similar effects. Insufficient funds display a significant impact on the odds of being vulnerable, yet these results are questionable when factoring in this paper's entire analysis. Having a financial account reduces the odds of vulnerability by half.

The previous variables are endogenous as a result of reverse causality. They are corrected for in a three stage system using the previously mentioned IVs. The following are the results of the key dependent variable, vulnerability:

Table 4.7: Logit for Vulnerability after Controlling for Endogeneity

	(1) Vulnerable	(2) Vulnerable	(3) Vulnerable
Credit*	0.570*		
	(2.02)		
Savings*	-0.845***	-0.458***	-0.729***
	(-4.10)	(-3.82)	(-4.55)
Government Support	0.270	0.469	0.231
	(1.03)	(1.87)	(0.86)
Farmer	-0.0167	0.153	-0.0395
	(-0.08)	(0.86)	(-0.20)
Income Quintile	-0.229***	-0.165**	-0.187***
	(-3.67)	(-2.97)	(-3.34)
Insufficient Funds	0.241	0.337	0.198
	(0.90)	(1.21)	(0.70)
Account	0.547*	1.053**	0.339
	(2.08)	(2.79)	(1.14)
Education	-0.0242	-0.111	-0.103
	(-0.16)	(-0.78)	(-0.72)
Female	-0.00452	0.0490	0.0121
	(-0.03)	(0.34)	(0.09)
Age	-0.00213	0.00687	0.00631
	(-0.37)	(0.80)	(0.88)
Formal Loans*		-0.180	
		(-1.43)	
Informal Loans*			0.683*
			(2.05)
_cons	0.393	-0.781	0.471
	(0.97)	(-0.88)	(1.15)
N	968	968	968

t statistics in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

The corrected results confirm the robustness of the initial results from the 3SLS simultaneity model. With one-unit increases in savings, the log of odds of considering oneself vulnerable to shocks drops approximately by 0.8. Meanwhile, informal credit continues to appear to be a source of distress. If an individual takes out loans from informal sources, the log-odds of reporting vulnerability rises by 0.68. Informal credit is the main driver of the positive effect all credit has on vulnerability. In fact, loans from formal sources reduce the odds of vulnerability, but that effect is insignificant.

If an individual moves up by one unit to a higher income quintile, the odds of them reporting vulnerability drops by around 0.2 at a significance level of $p < 0$. This result has been verified through all models and was isolated earlier to non-farmers. On the other hand, having a financial account in this case increases the odds of being vulnerable. Financial penetration's effect on vulnerability is hard to pigeonhole. For example, it loses significance when informal loans replace formal loans, while the rest of the estimates hold up. The only sturdy result is its positive influence on savings.

4.6 Asymmetric Correlation and External Credit Rationing

Across all models, vulnerability displayed no impact on credit, while credit repeatedly resulted in a positive estimate on vulnerability. There was an asymmetry between estimates in terms of signs and, more importantly, in significance. On the other hand, savings and vulnerability showed a symmetric correlation across stages.

The asymmetry can help explain the cause of the repressed usage of formal loans. With farmers, formal loans displayed a negative effect on vulnerability, which is asymmetric to the

effect of informal loans. Meanwhile, there exists no relationship from vulnerability on either types of loans.

I can therefore speculate on causality and point at a substitution effect between formal and informal loans. In other words, the reason vulnerable farmers borrow more informally could be the result of external credit rationing.

External credit rationing is imposed by the lender. The concept occurs when institutions are not willing to lend credit to the borrower when the borrower does not possess enough collateral to reduce the risk. Another cause of external credit rationing is the regulatory environment of the lending institutions (Barry *et al*, 1995: 194-199).

What this tells us about the regulatory environment is that financial institutions are able to assess the creditworthiness of an individual in a better way than relatives and friends can. Borrowers who are turned down by institutions resort to lending from family members who are not able to form objective decisions about a person's creditworthiness. Formal lenders assess investments objectively, while family members can be biased towards supporting any investment by a family member. However, since this asymmetry is limited to farmers, it may appear that formal lenders deem agricultural investments more risk.

As I had mentioned earlier in this paper, financial institutions are short on lending in Kenya, resulting in the aforementioned external credit rationing. The low usage of formal credit is not the result of low demand but of reluctant supply, and RCCs can reduce people's riskiness and resolve this issue.

4.7 Chapter Summary

For my model, I ran a three stage simultaneous equation model to control for the endogeneity of savings, credit, and vulnerability. These variables displayed a simultaneity bias amongst themselves.

The major finding is credit's positive impact on an individual's vulnerability. The positive sign is isolated to loans from informal sources, while formal loans reduces one's vulnerability – especially with farmers. This indicates a restrictive formal sector that assesses lenders' investments more aptly than informal sources do.

No variable significantly impacts credit, while credit improves savings. Meanwhile, savings reduces one's vulnerability across all samples. Having a financial account did not maintain robustness across models. In other words, having an account at a financial institution does not guarantee the usage of services such as loans. Having an account did however increase savings, but with non-farmers only.

In addition to the three key variables, an individual's income also showed significant results. Wealth reduced individuals' vulnerability. These results maintained robustness with the three-stage logit model.

CHAPTER V

CONCLUSION

5.1 Recommendations for the SATISFy Project

The "SATISFy" project seeks to aid the vulnerable by introducing them to Risk-Contingent Credit. This paper finds that a significant factor in determining the vulnerable population of Kenya is wealth; jumping income quintiles reduces vulnerability. However, this result is limited to non-farmers. Since RCCs are targeted to vulnerable farmers, this population's wealth should not be significantly relevant.

What does influence the composition of the vulnerable population are savings and informal loans. Savings relieves vulnerability, while taking out loans from informal sources increases it. The latter is an indicator that there is room for the formal financial sector since the informal sector is a source of anxiety. In the promotion of RCCs, this result could be capitalized on.

That being said, vulnerability does not play a significant role in the usage formal credit. This is significant since RCC is in itself a form of formal credit. In fact, no measured variable does have an impact. The literature on credit and insurance points heavily at collateral requirements' role in this regard, and this leaves room for that possibility.

A spillover effect of rendering credit accessible through RCCs is its positive impact on savings. Savings in turn eases vulnerability. The reason savings' positive effect on credit is minimal could be the result of the small size of the lending sector in Kenya. RCCs theoretically broaden that sector, therefore strengthening savings' impact on borrowing. The project should analyze the role the presence of savings has on the take-up of RCCs, as well as the change in savings occurring with the purchase of this instrument.

Financial penetration's impact is almost exclusive to savings. People with accounts at institutions tend to save more. Having a financial account does not indicate an increased level of borrowing from these institutions. The usage of credit services is dry. Yet the usage of informal loans is high, indicating a significant demand for borrowing. The asymmetry between formal loans and vulnerability, and informal loans and vulnerability, points to external credit rationing. Demand for credit exists, yet the low usage is institutional. Therefore, uptake of RCCs looks to be high.

5.2 Conclusion

In this thesis, I showed that Kenyan lenders are reluctant to enter the agriculture sector. Most Kenyan farmers rely on informal lending for their investments. However, I find in this paper than informal lending is a source of stress for farmers, who have a more positive outlook towards formal lending. This indicates a mismatch between demand and supply for loans from formal sources, and its cause is institutional due to external credit rationing. Institutions are not willing to lend borrowers while family members are. What this tells us is that institutions run a much more objective assessment of borrowers' investments than relatives do.

Additionally, policies encouraging financial inclusion in developing economies have focused their efforts on encouraging individuals to reach out to banks and open accounts. Yet my results indicate that having an account does not necessitate the usage of services such as credit, which reduces vulnerability. However, having an account can improve savings, which in turn can reduce vulnerability, although these results were limited to non-farmers. As a next step, I recommend an analysis of panel data for individuals as they face shocks and as they manage their finances.

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